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Pacific Northwest Research Station

United States Department of the Interior
Bureau of Land Management

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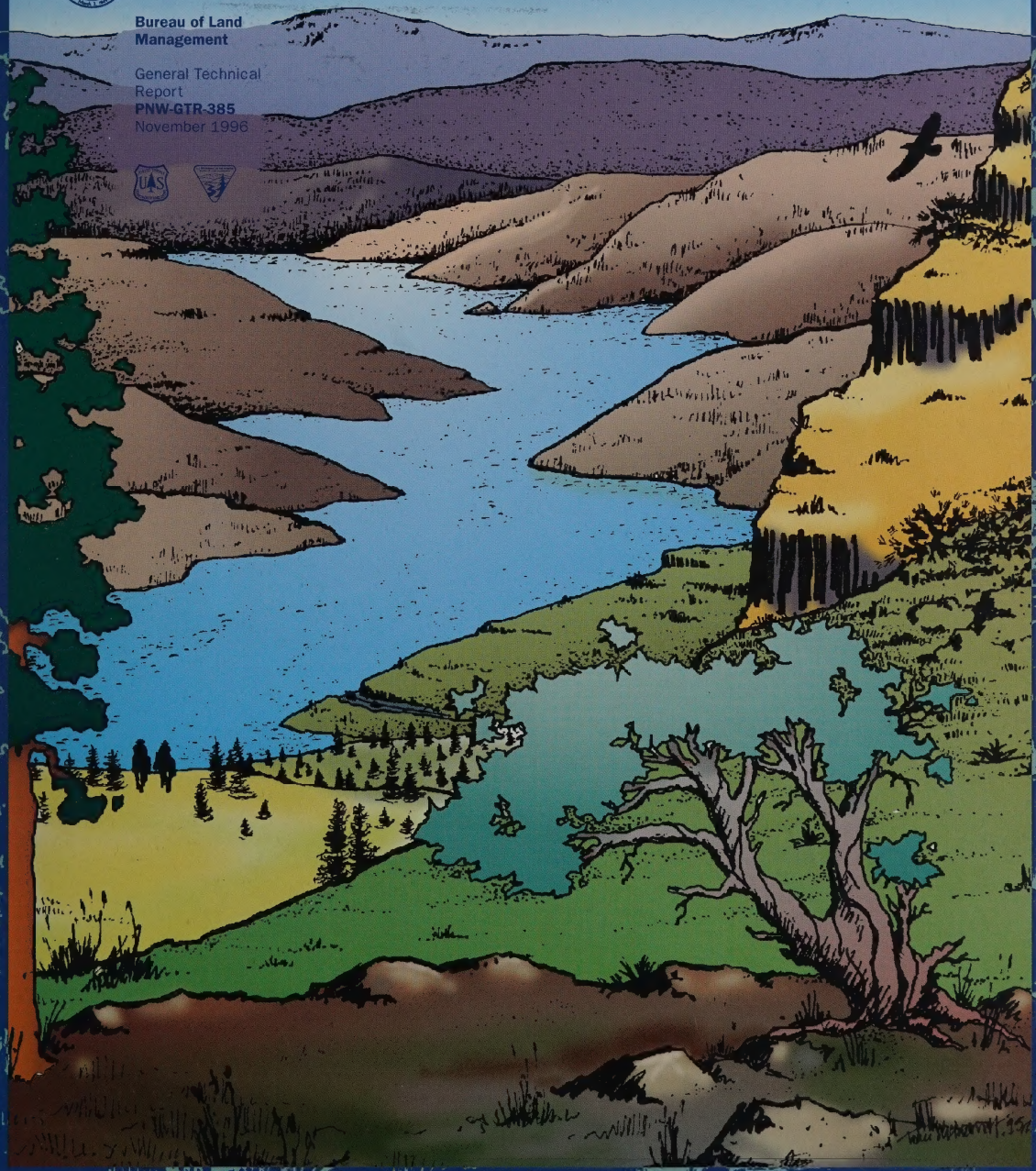
November 1996

Status of the Interior Columbia Basin

Summary of Scientific Findings



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Interior Columbia Basin Ecosystem Management Project

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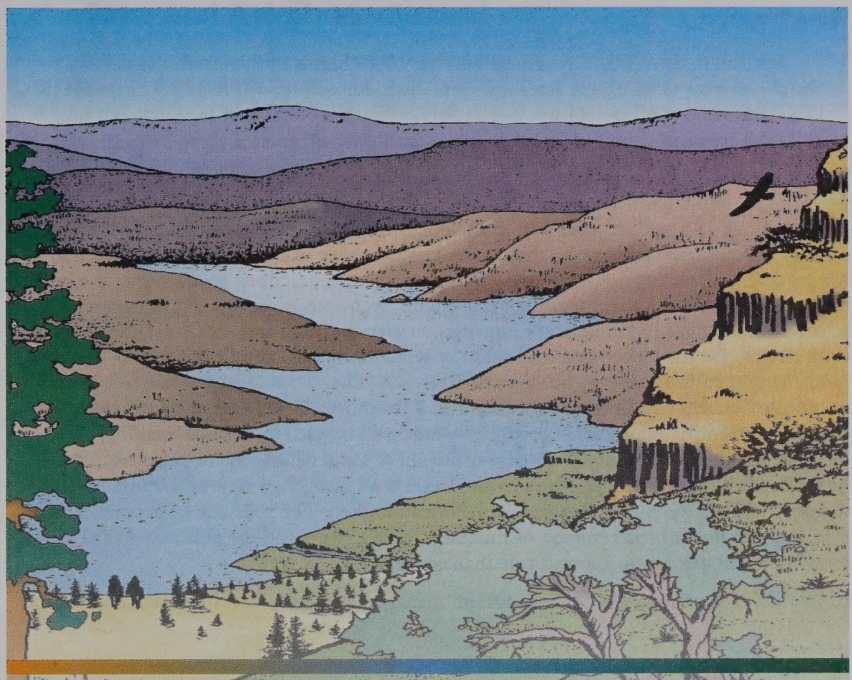

Status of the Interior Columbia Basin
Summary of Scientific Findings

November 1996
United States Department of Agriculture
Forest Service
Pacific Northwest Research Station
Portland, Oregon

Abstract

U.S. Department of Agriculture, Forest Service. 1996. Status of the interior Columbia basin: summary of scientific findings. Gen. Tech. Rep. PNW-GTR-385. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; U.S. Department of the Interior, Bureau of Land Management. 144 p.

The *Status of the Interior Columbia Basin* is a summary of the scientific findings from the Interior Columbia Basin Ecosystem Management Project. The Interior Columbia Basin includes some 145 million acres within the northwestern United States. Over 75 million acres of this area are managed by the USDA Forest Service or the USDI Bureau of Land Management. A framework for ecosystem management is described that assumes the broad purpose is to maintain the integrity of ecosystems over time and space. An integrated scientific assessment links landscape, aquatic, terrestrial, social, and economic characterizations to describe the biophysical and social systems. Ecosystem conditions within the Basin have changed substantially within the last 100 years. The status of ecosystems is described in terms of current conditions and trends under three broadly defined management options. The scientific information brought forward will be used in decision-making, and may potentially amend Forest Service and Bureau of Land Management plans within the Basin. The information highlighted here represents an integrated view of biophysical and socioeconomic elements at a scale never before attempted. The risks and opportunities are characterized in the broad context of the Basin for managers and the public to use as a foundation for discussion about future management.

Keywords: ecosystem assessment, ecosystem management, ecosystem integrity, risk analysis.

Preface and Acknowledgment

This report summarizes over 2,000 pages of scientific, technical methods and findings produced by the project's Science Team. Summarizing this much material while also attempting to make it understandable and accessible to a diverse audience was a difficult task. The result provides readers with an overview of the topics covered and key findings. The original documents contain much greater detail and explanation, as well as covering related topics not mentioned here. Readers are encouraged to consult those documents for the full story of Basin ecosystems. We decided not to incorporate references or citations into this summary document to keep it more readable for a broad audience; the full versions of the science documents contain references to all materials used. This report does not summarize material contained in the project's two draft environmental impact statements, which were not released at the time this summary was printed.

This report was prepared by Stewart Allen from material contained in science documents developed for publication by the Interior Columbia Basin Ecosystem Management Project. Tom Quigley verified the scientific accuracy of the summarized material and edited the initial draft; Jodi Clifford and Liz Galli-Noble also edited various drafts. Many of the authors of the science documents also reviewed a draft version. Del Thompson supervised layout and printing. Photographs were taken by Larry Frank, Wendel Hann, Rod Johnson, Mike Northrop, Jane Rohling, K.D. Swann, and Stewart Allen; historical photos courtesy of Deschutes County Historical Society.

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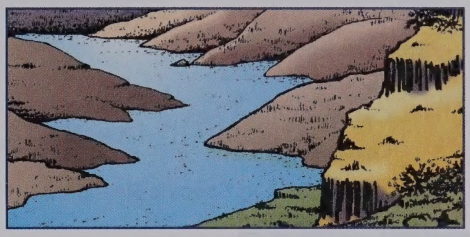

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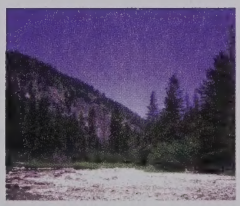

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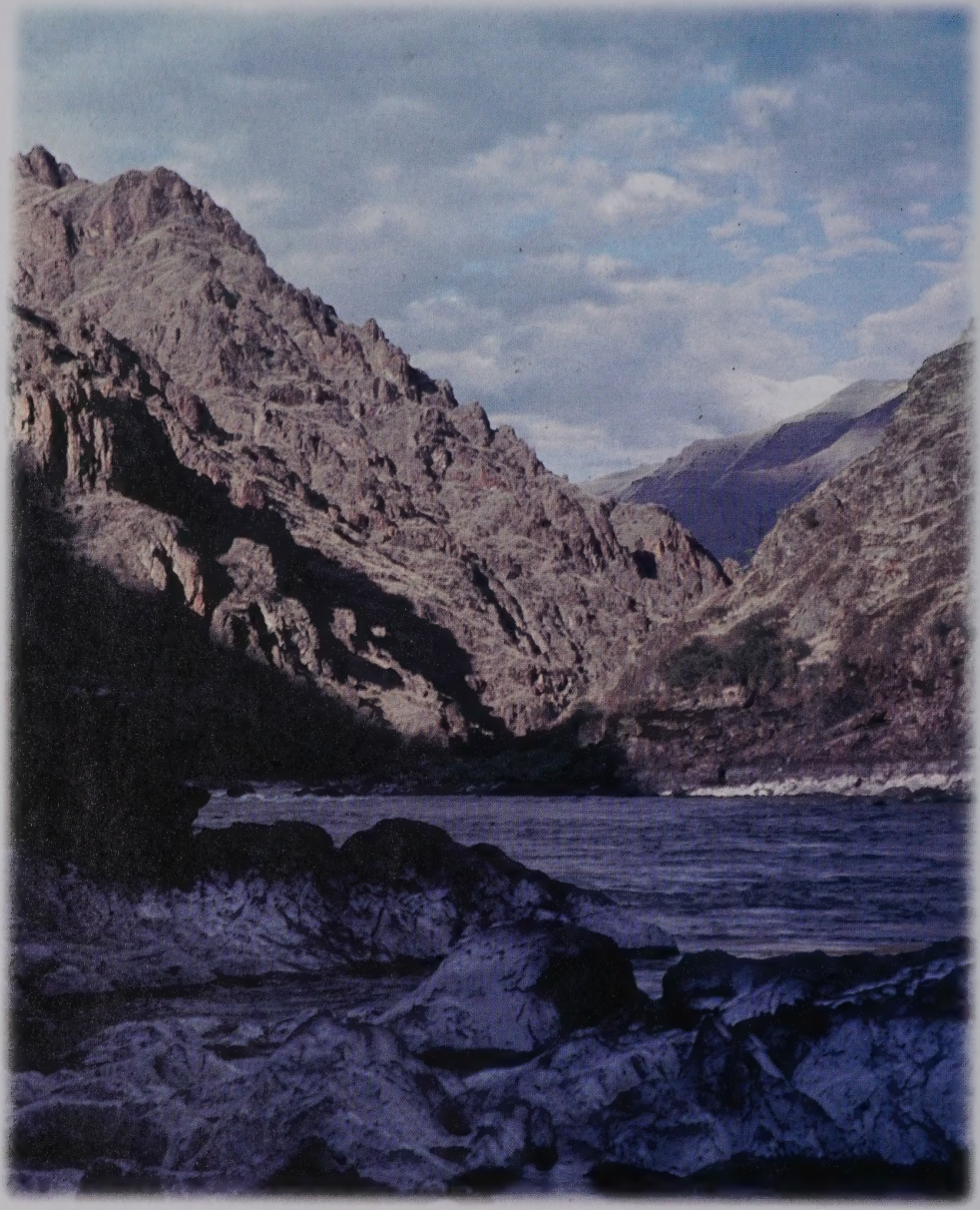
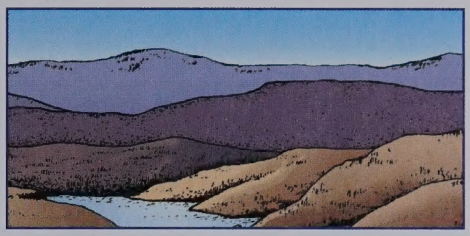


INTRODUCTION



The Pacific Northwest has been involved in controversy over the ownership and management of natural resources since descendants of Europeans began inhabiting the area 150 years ago. After World War II, the debate over management of public lands focused primarily on resource allocation, as commodity production took precedence over early twentieth century custodial protection of public lands. In the last decade, however, concerns have grown about issues related to species associated with old forest structures, anadromous fish, forest health, widespread insect and disease mortality and fire, and rangeland health. This broader concern for ecosystem conditions recognizes that such conditions not only reflect the quality and extent of habitats available for plant, animal, and fish species, but also the ability of lands and waters to provide continued, predictable flows of resources that contribute to both traditional and current human values and demands.

In the wake of studies addressing biophysical, social, and economic issues concerning forest management west of the Cascades, the need for an integrated understanding of conditions on the east side was recognized. Although numerous reports had addressed many forest health problems on the east side, the status of the Basin as a whole had never been assessed.

The Project

The Interior Columbia Basin Ecosystem Management Project evolved from the current debate over management of lands administered by the U.S. Department of Agriculture, Forest Service (FS) and U.S. Department of Interior, Bureau of Land Management (BLM) in the Columbia River basin within the United States and east of the Cascade crest, and portions of the Klamath and Great basins in Oregon. This sparsely populated 145-million-acre area, referred to here as simply the "Basin," contains a wealth of natural resources and related opportunities.

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) was established by the Eastside Ecosystem Management Project Charter in January 1994. The Charter, signed by the Chief of the Forest Service and the Director of the Bureau of Land Management, directed the agencies to undertake work necessary to develop and then adopt a scientifically sound, ecosystem-based strategy for managing all FS- or BLM-administered lands within the Basin.

Although numerous reports had addressed many forest health problems on the east side, the status of the Basin as a whole had never been assessed.

The Columbia River Gorge near Hood River, Oregon.

This work has had many components. First, it was necessary to describe how ecosystems operate—the principles important to understand when embarking on such an ambitious project. This was the goal of one of the main project documents, called *A Framework for Ecosystem Management in the Interior Columbia Basin and Portions of the Klamath and Great Basins.* The *Framework* describes principles, goals, and processes applicable to managing ecosystems in the Basin.

The next step was to develop a better understanding of the current biophysical, economic, and social conditions and trends in the Basin. This information is summarized in the document, *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins.* The *Component Assessment* examines ecosystems within the Basin, including their history, current status, and trends, and offers projections of future conditions. The *Component Assessment* included Federal, state, county, and private lands and resources within the Basin. Though direction is being developed only for lands administered by the FS or BLM, it is important to know how these lands fit into the overall Basin ecosystem.

Because the assessment was conducted by resource area (biophysical, landscape dynamics, terrestrial, aquatic, economic, and social), another analysis integrated those resource-specific findings to develop

The inclusion of a decision component, in the form of two environmental impact statements, is one of the aspects that makes the project unique.

an overall picture of the status of Basin ecosystems. This analysis is reported in the project's *Integrated Scientific Assessment for Ecosystem Management.*

This summary report concentrates on material presented in these three ICBEMP documents—the *Framework*, the *Component Assessment*, and the *Integrated Assessment.*

The Charter also called for preparation of two Environmental Impact Statements (EISs), one establishing direction for FS- and BLM-administered lands in eastern Washington and Oregon, and the other for lands in the upper Columbia basin (Idaho, northwestern Montana, and portions of Nevada, Utah, and Wyoming). The EISs, which will identify and evaluate alternative ways of implementing ecosystem management, are designed to modify existing FS and BLM land management plans. As part of the EIS process, a scientific evaluation of the EIS alternatives was conducted; it will be available as another project document.

The inclusion of a decision component, in the form of two environmental impact statements, is one of the aspects that makes the project unique. While other broadscale assessments are being conducted in the United States, such as those recently completed for the Sierra Nevada and Southern Appalachian ecosystems, they do not include a decision component in the form of an EIS or similar document. Another unique aspect of this project is the sheer scale of the assessment area—145 million acres, compared with 37 million acres for the Southern Appalachian assessment, or 21 million acres for the core area of the Sierra Nevada assessment.

The Basin

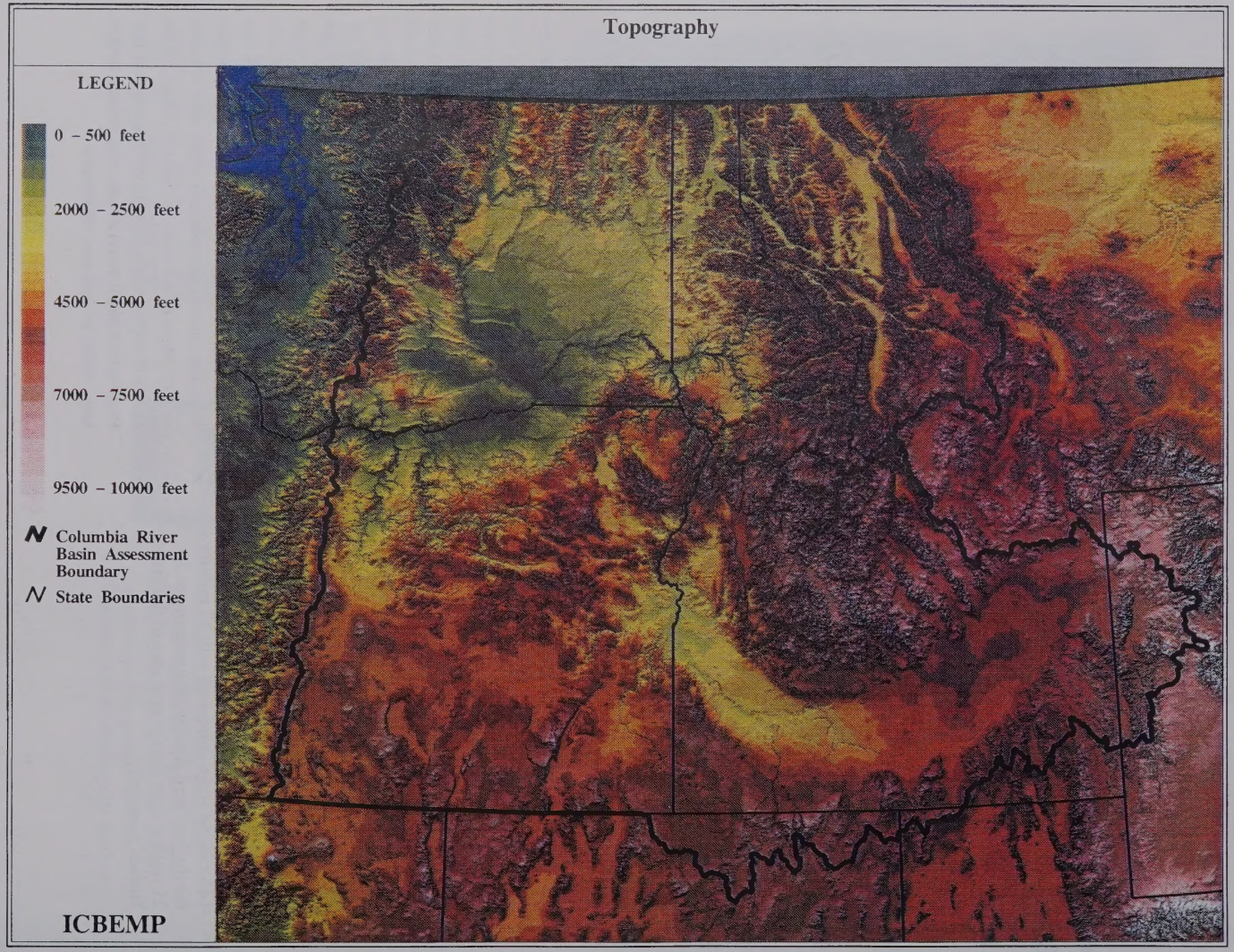
A quick snapshot of the Basin is a good starting point. Basin lands are highly diverse, ranging from the Cascades on the west to the continental divide in the Rocky Mountains on the northeast and east (**map 1**). Several mountain ranges in central Idaho and western Montana commonly have elevations over 10,000 feet. The Basin includes the extensive basalt plateau of eastern Oregon, eastern Washington, and southern Idaho as well the high desert of the Klamath Basin in southwest Oregon and the plains of the Great Basin in northern Nevada, northern Utah, and southern Idaho.

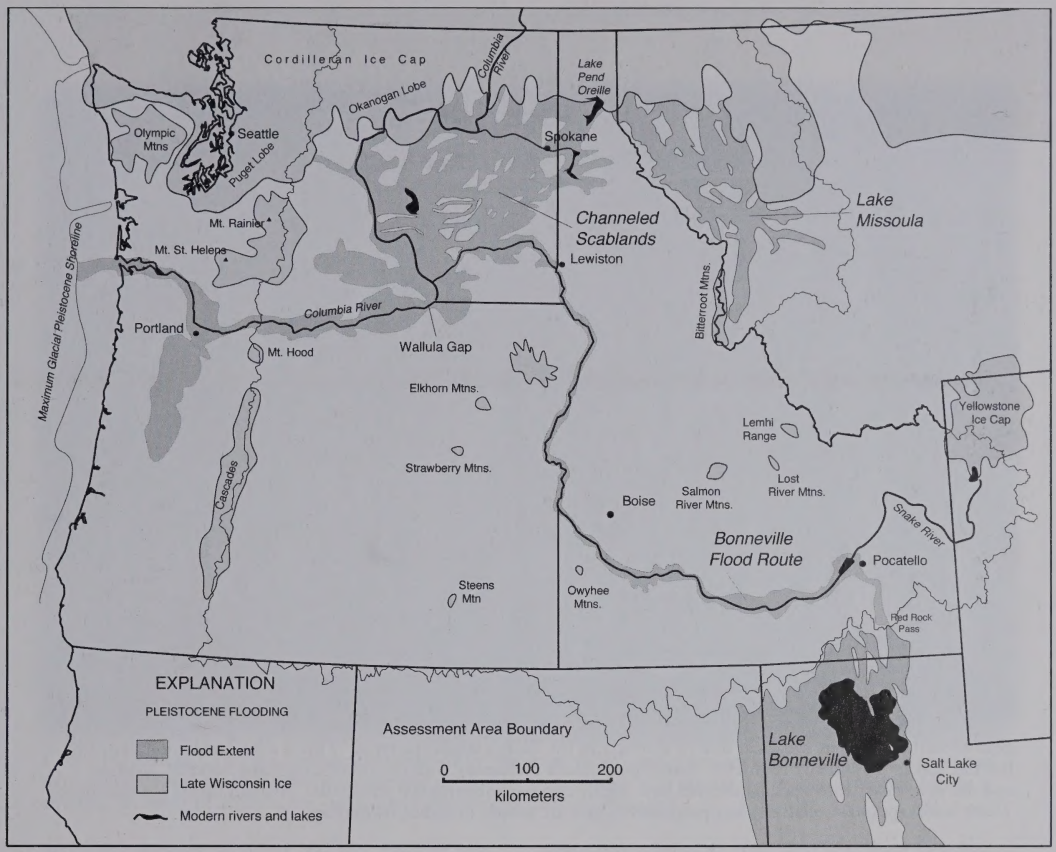
Events during the Pleistocene epoch shaped much of the Basin's landscape. Continental ice sheets originating in Canada excavated and molded valleys in the northern portion of the Basin, while alpine glaciers occurred in most of the mountainous areas. As a result of a prolonged wet climate, many large lakes formed, particularly in southern portions of the Basin. Repeated breaching

Public Participation

The ICBEMP was committed to an open process with numerous and diverse opportunities for public involvement during the project. The public was encouraged to attend the workshops and regularly scheduled public sessions held throughout the Basin. At these briefings, project staff and management discussed the latest scientific findings and provided updates on progress, with time for interaction between scientists and attendees. Reports from contractors and other draft materials were made available to the public through a variety of means. Much of the material was available in an electronic library maintained by project personnel, and data layers and maps were released as they became final and documented. Other special efforts to communicate with the public included a day-long conference on social issues and findings, held in April, 1995, in Spokane, Washington.

Map 1—Basin topography.





Map 2—Pleistocene events in the Basin.

of ice dams by glacial Lake Missoula led to cataclysmic flooding that carved the "channeled scablands" of eastern Washington (**map 2**). Spillovers of pluvial Lake Bonneville into the Snake River system modified the valley of the Snake River and left large cataract complexes. Sedimentary deposits including glacial till, outwash and loess, and valley fill, terraces, and scour features occur over much of the Basin. Soils developed from loess deposits in the Columbia Plateau and Snake River plain have enabled these areas to develop into highly-productive agricultural areas, such as the Palouse.

The Basin is in a transition-type climate zone where climate patterns are dominated by topographic features. Type and distribution of vegetation varies with soils, long-term precipitation patterns, and climate. Forested vegetation differs among dry, moist, and cold vegetation types. Grassland, shrubland, and woodlands are also present across the Basin. These differ between

The Basin is sparsely populated, covering about eight percent of the land area of the United States while containing about one percent of the Nation's population.

Blue Mountains. There is a great deal of diversity in the Basin's landscape types. This is a landscape dominated by foothill and mountain environments. Land uses include recreation, forestry, livestock grazing, wildlife, fisheries and use as a watershed. Such landscapes have highly dynamic disturbance potentials. Fire and floods are common. These landscapes have relatively low productivity and are mostly in public ownership.

desert (very dry) areas and high elevation (very cold) areas.

Most of the area is drained by the Columbia River and its tributaries. The portion of the Klamath Basin that occurs in the project area is drained by the Klamath River and its tributaries; the portion of the Great Basin that occurs in the project area has closed basins. Stream modifications to facilitate navigation on the Columbia River system began in 1876 with construction of locks and canals. By 1975, the waterway between Lewiston, Idaho, and the Pacific Ocean had become a series of reservoirs.

The Basin is sparsely populated, covering about eight percent of the land area of the United States while containing about one percent of the Nation's population. This results in a population density less than one-sixth of the U.S. average. Like much of the rural West, the Basin has experienced recent, rapid population growth that is expected to continue. The Basin contains nearly 500 small, rural communities of 10,000 people or fewer that have been undergoing significant social and economic change.

The Basin has a diverse economy that makes up just under 4 percent of the U.S. economy. Six metropolitan areas have been the centers of its

Columbia Plateau. This is a landscape dominated by plains (or valley) environments with mixed forest, range, and agriculture. These types of landscapes are very productive and are mostly in private ownership. They are highly dynamic in terms of disturbance, particularly climatic fluctuations (drought).

economic growth: Spokane, Yakima, Pasco/Kennewick/Richland ("Tri-Cities"), and Wenatchee, Washington; Bend, Oregon; and Boise, Idaho. The past two decades have seen the evolution of what was a mature, resource-based economy into a diverse economy oriented toward the technology, transportation, and service sectors. Economic strengths of the Basin include agriculture and agricultural services.

Of the 145 million acres in the Basin, 53 percent is public land managed by the BLM or the FS through 35 National Forests and 17 BLM Districts (**map 3**). The project area contains all or significant portions of 100 counties across seven states (**map 4**). This makes it clear, as will be discussed later, that the Forest Service and Bureau of Land Management will need help from others to make ecosystem management work. The Basin contains about 24 percent of the Nation's National Forest system lands and 10 percent of the Nation's BLM-administered lands. Designated Wilderness within the Basin, present in 46 of the 100 counties, totals just over 10 million acres—about 29 percent of the Wilderness acres within the contiguous United States.

Map 3—Major land ownerships within the Basin.

Map 4—Counties in the Interior Columbia Basin project area.

Ecosystem Principles

Understanding ecosystem management requires defining ecosystems and the principles under which they operate. An ecosystem is a complete, interacting system of living organisms and the land and water that make up their environment—the home places of all living things, including humans (**figure 1**). Because humans have developed the capacity to rapidly alter the environment beyond the capacity of any other species and because humans are dependent, like all species, on the environment, humans are included as a component of ecosystems.

Ecosystems

Ecosystems are places where all plants, animals, soils, waters, climate, people, and processes of life interact as a whole. They may be small, such as a rotting log, or large, such as an entire continent; smaller ecosystems are subsets of larger ones. All ecosystems have flows of things—organisms, energy, water, air, nutrients—moving among them. Ecosystems change over space and time, so it is not possible to draw a line around an ecosystem and try to keep it the same. Instead, managing ecosystems means understanding and working with the processes that cause ecosystems to vary and to change.

Concepts and principles underlying ecosystem management are evolving. Four broad principles guided the ICBEMP:

Ecosystems are dynamic, evolutionary, and resilient;

Ecosystems are viewed spatially and temporally within organizational levels;

Ecosystems have biophysical, economic, and social limits; and

Ecosystem patterns and processes are not completely predictable.

Ecosystems are dynamic; they change with or without human influence. Existing ecosystem conditions are a product of natural and human history—including fire, flood, and other disturbances, climatic shifts, and geological events such as landslides and volcanic eruptions. Change is inherent in ecosystems. An ecosystem is said to be resilient if it tends to return to some developmental pathway when disturbed or otherwise changed, or if its state is always changing within some definable bounds. While ecosystem management can recognize the inherent resiliency of natural systems, it should also recognize that maintaining the status quo is difficult and not necessarily a goal. Just as disturbances and the actions of human generations shaped the ecosystems of today, actions of this generation will transform ecosystems of the future.

Ecosystems and the links among them can be studied at a variety of scales. Ecosystems can vary in size, for example, from a small pond to an entire river basin. To describe the dynamic nature of ecosystems, it is useful to view them as having multiple organizational levels differing over time and space. These levels can be organized within

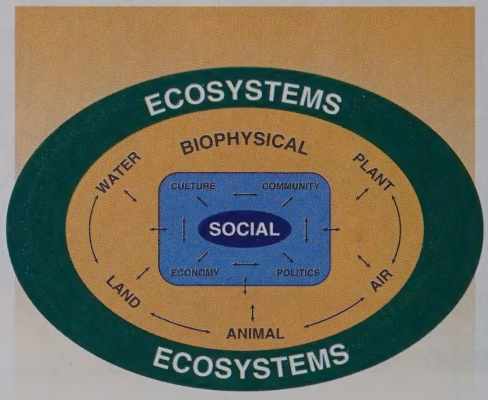


Figure 1—Ecosystems are places where biophysical and social components interact as a whole. All ecosystems have flows of energy, organisms, water, air, and nutrients and each element is affected by other elements. All ecosystems change over space and time.

Ecosystems can vary in size and scale, as demonstrated by these three scenes from the White Salmon River at the Basin's western boundary.

hierarchies, in which every level has discrete ecological functions but at the same time is part of a larger whole. Higher levels usually occupy larger areas and are usually characterized by longer timeframes. Spatial extent can range from a few square meters to millions of square meters, and timeframes can range from less than one year to millions of years.

The main purpose of the data collection portion of the ICBEMP was to gain an understanding of the Basin as a whole, but for individual resource areas data were collected and analyzed at many smaller scales as well. This is crucial because the Basin is so diverse that "average" numbers tend to be very misleading and fail to reflect the vast differences present. Aquatics and other analyses, for example, were conducted at watershed, subbasin, and basin scales. For other analyses, the Basin was divided into 13 ecologically distinct areas called Ecological Reporting Units. Social and economic information was generally at the state or county level of analysis. Bureau of Economic Analysis reporting areas were used to characterize centers of trade and economic activity. However, measuring social and economic conditions only at these scales would mask differences among the many communities within the Basin, so the project also collected information about hundreds of small, rural communities. There is no "right" level of analysis; the appropriate scale depends on what question is being answered, and it is useful to study ecosystem conditions at multiple levels to understand how one set of conditions depends on and affects another.

Ecosystem processes such as soil formation that occur over long periods (centuries or millennia) hold little meaning for political processes that operate biennially.

Organizational levels, timeframes, and spatial extents that are significant to human decision-making often do not correspond to the same timeframes and spatial extents as biophysical systems. Ecosystem processes such as soil formation that occur over long periods (centuries or millennia) hold little meaning for political processes that operate biennially. In addition, people respond to environments symbolically, and places important to people cannot typically be defined by using biophysical hierarchies alone. To some extent, the selection of hierarchies represents a compromise among the various disciplines involved in an assessment.

Ecosystems have biophysical, economic, and social limits. The environment is constantly in a state of flux, causing ecosystems to change. Given this, human populations recognize that the ability of an ecosystem to provide goods and services has limitations. Unfortunately, people also often make demands on ecosystems that exceed the system's biological or physical capabilities. Science provides information about ecosystem limits; society uses this shared information to make choices about its behavior. Land managers then use this information as they develop ways to allocate finite resources. People can choose to modify their behavior and organize their institutions to be consistent with the capabilities of ecosystems, or they can pursue actions inconsistent with the capabilities of ecosystems. People can also improve ecosystem productivity on some sites through investments in management practices. Societal choices regarding the use and allocation of resources have implications for inter-generational equity and tradeoffs.

There are limits to our ability to predict how ecosystems may change. Even the best modeling systems that try to predict what will happen to an ecosystem are only guesses, subject to a variety of assumptions and uncertainties. This is true for both human and nonhuman components of ecosystems. The events that influence ecosystem

Salmon River in the Frank Church River of No Return Wilderness Area. Society has already chosen to set aside some resources from many types of uses by humans. This does not mean, however, that the landscape will remain the same; successional and disturbance processes continue to operate.

patterns and processes are usually unpredictable, and predictability varies over temporal and spatial organizational levels. For example, from year-to-year wildfire occurrences are associated with particular seasons and environmental conditions, but a fire may occur in any season and under many different environmental conditions. Similarly, eruptions of volcanos in the Cascade Mountain Range have occurred, on average, twice each century for the past 4,000 years; however, neither when the next eruption will occur, nor its size and effects, can be predicted. In the social dimension, predicting crime rates at the regional or community level is possible, but it is much more difficult to predict the occurrence of a crime at a particular household.

The limited predictability of ecosystem outcomes has several important implications. Land management policies and practices should give managers sufficient flexibility to respond effectively to any unanticipated effects of previous decisions. As knowledge increases, managers are better able to predict outcomes, yet long-term yields of goods and services may remain unpredictable. Finally, although models are simplistic representations of real world systems, they may improve the predictability of outcomes.

Ecosystem Management

The institutional framework and societal desires surrounding public land stewardship continuously evolve. In the course of U.S. history, major land management themes have changed from privatization (1800-1891), to conservation and scientific management (1891-1945), to commodity production (1945-1960), to increasingly complex and contentious demands (1960-present). Today, the agencies are faced with attempting to balance these traditional issues with demands for and greater concern over ecosystem health and fire management.

It is not just Basin ecosystems that have changed, but how society views resources and makes decisions about their use. The 1990s are characterized by public concern over ecosystems and their physical, biological, economic, and social conditions. There is widespread concern for forests, rangelands, rivers, and the species dependent on them—including humans and in particular the residents of small, rural communities in the Basin. The costs and benefits of activities such as salvage logging and its appropriate role have emerged as national issues. Aggressive fire suppression policies of Federal land-managing agencies have been increasingly criticized as more has been learned about natural fire cycles. Rangeland ecosystems in large areas of the Basin have been altered dramatically by land use conversion and the accidental and deliberate introduction of non-native species. Noxious weeds threaten rangeland vegetation upon which both wild and domestic animals depend. The costs of these and other changes have been measured not just in the listing of endangered species but in appeals, court decisions, and regulations that have decreased the availability and predictability of public land management outputs such as timber.

The Forest Service and the BLM response to these emerging social and environmental issues is ecosystem management, a relatively new term that has been given varied definitions and has a wide variety of connotations for people. Ecosystem management is scientifically-based land and resource management that integrates ecological capabilities with social values and economic relations to produce, restore, or sustain ecosystem integrity and desired conditions, uses, products, values, and services over the long term. The Chief of the Forest Service has described ecosystem management as the next intelligent evolution of multiple use. One of the main distinctions of ecosystem management is that it concentrates on overall ecosystem health and productivity through an understanding of how different parts of the ecosystem function with each other, rather than on achieving a set of outputs. Human activities, including social values about demands on public lands and biophysical ecosystem components, are part of the total picture.

One of the main distinctions of ecosystem management is that it concentrates on overall ecosystem health and productivity through an understanding of how different parts of the ecosystem function with each other, rather than on achieving a set of outputs.

Federal land management agencies have legal and social obligations to sustain the health, diversity, and productivity of ecosystems for the benefit of present and future generations. In addition, they are obligated to fulfill responsibilities assumed from treaties with American Indian tribes including maintaining or restoring viable, and in some cases harvestable, populations of plants and

Owyhee River canyon in southeastern Oregon. Ecosystem management attempts to look at the total picture and manage with an understanding of how ecosystems function.

animals. Satisfying these obligations is often complicated by changing and competing public values, the constant march of science, and land ownership and jurisdictional patterns that do not correspond to ecosystem patterns.

Ecosystem management, in this sense, is another stage in the agencies' evolving efforts to satisfy their obligation to stakeholders while striving to resolve these complications. Stakeholders include tribal, state, county, local governments, private land holders, and individuals or groups representing local and national interests in land management. Stakeholders also include all of the citizens of the United States who use, value, and depend on the goods, services, and amenities produced by federally administered public lands.

The meaning of ecosystem management as it applies to FS- and BLM-administered lands in the Basin would be better understood if accompanied by a broad set of goals that describe its overall intent. However, ecosystem management goals will be chosen and implemented by land managers, because identifying goals is a policy decision, rather than a scientific one. The ICBEMP's two environmental impact statements will identify draft goals. In the absence of the actual goals, scientists working on the project developed a list of illustrative management goals (fully described in the *Framework*) to help examine the status of eco-

The Role of Science

The role of science in the ecosystem management model is to provide information for the decision-making process. Such information helps to identify the current status of ecosystems as well as potential options for addressing issues; the social, physical, economic, and biological consequences of those options; and tradeoffs among options. Science, however, cannot choose among the options; that is the role of decision-makers. Recognition of these distinct responsibilities led the project to establish two main teams of staff: scientists, who wrote the science documents summarized here; and management, who will ultimately make decisions (through the EIS process) about how to carry out ecosystem management on FS- and BLM-administered lands in the Basin.

systems within the Basin. These goals reflect the diverse views that humans have about ecosystem management:

- Maintain evolutionary and ecological processes
- Manage in the context of multiple ecological domains and evolutionary timeframes
- Maintain viable populations of native and desired non-native species
- Encourage social and economic resiliency
- Manage for the human sense of "place"
- Manage to maintain the mix of ecosystem goods, functions, and conditions that society wants

These are reasonable assumptions about management goals because they explicitly recognize the ways in which humans depend on and interact with the environment in our modern world. They seek to reduce risk from ecological surprises and acknowledge important social values derived from commodity and non-commodity use of natural resources. The goals are therefore assumed to provide important benchmarks against which to measure the progress of ecosystem management. If adopted, they would force decision-makers to explicitly consider the extensive range of values and choices involved in ecosystem management.

The goals and the four ecosystem principles described above suggest the need for an adaptive approach to management—an approach that can be adjusted in response to new information. A general planning model for ecosystem management has four iterative steps (**figure 2**); monitoring, assessment, decision-making, and implementation occur in a cyclic process. Each step has considerable room for both formal and informal public participation.

In the model, monitoring is the process of collecting and evaluating information to determine baseline conditions or to determine if planned activities have been accomplished, if assumptions are correct, and if management objectives have been met. Assessments, which begin by recognizing who the clients are and what questions they have, describes biophysical and social ecosystem components at various timeframes and scales. The decision-making step involves the full range of decision components, from identifying alternatives to selecting one for implementation. The implementation step is the process of turning plans and decisions into projects and practices on the ground.

This general planning model provides a context for integrating social, economic, and ecological information with management goals. It is not fundamentally different from existing ways that FS or BLM plans are developed, but the emphasis on monitoring—learning more about the effects of management actions—is greatly increased, as is the ability to respond to new knowledge as it is gained.

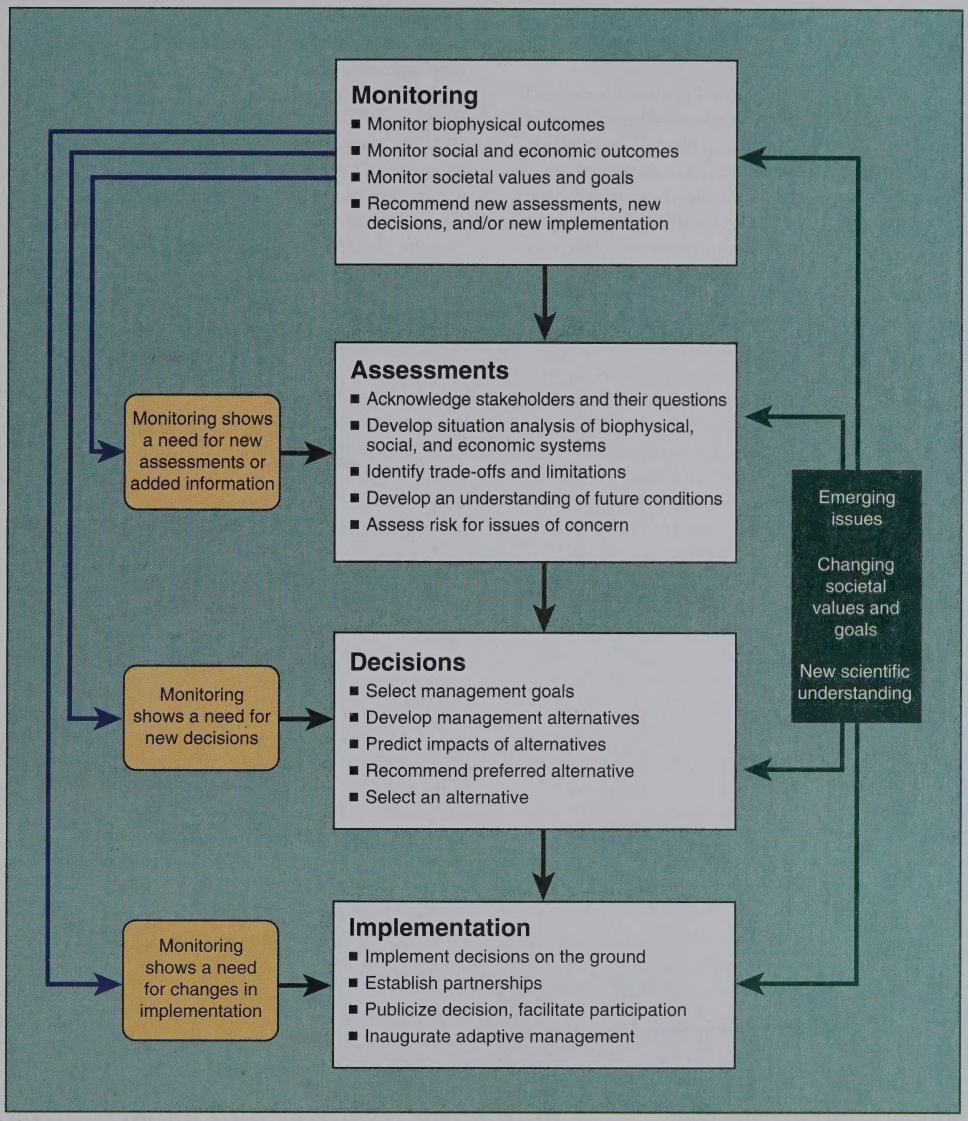

Monitoring
Monitor biophysical outcomes
Monitor social and economic outcomes
Monitor societal values and goals
Recommend new assessments, new decisions, and/or new implementation
Assessments
Acknowledge stakeholders and their questions
Develop situation analysis of biophysical, social, and economic systems
Identify trade-offs and limitations
Develop an understanding of future conditions
Assess risk for issues of concern
Decisions
Select management goals
Develop management alternatives
Predict impacts of alternatives
Recommend preferred alternative
Select an alternative
Implementation
Implement decisions on the ground
Establish partnerships
Publicize decision, facilitate participation
Inaugurate adaptive management
Monitoring shows a need for new assessments or added information
Monitoring shows a need for new decisions
Monitoring shows a need for changes in implementation
Emerging issues
Changing societal values and goals
New scientific understanding

Figure 2—Each step of the General Planning Model for ecosystem management has several parts. Because the model is iterative, external or internal influences can initiate any step in the process and the process never ends.

Evolving Role of the Public and Institutions

Determining societal expectations for outputs (goods and services) and ecological conditions is a key feature of the planning model. In adaptive management, decisions are made as part of an ongoing process in which actions are tested, their effects monitored, and the resulting knowledge is used to modify management plans and practices. Interaction with the public, elected officials, and Indian tribes, takes place on a continual basis, rather than being solely project-driven.

Previously, public participation often meant reacting to predetermined agency proposals on a project-by-project basis. In adaptive management, changes to this process are driven by a desire to improve understanding about and confidence in agency policies and actions, including ecosystem management, among stakeholders. Interagency coordination and intergovernmental (and sometimes international) cooperation are essential to the success of an ecosystem approach to Federal land management.

Many public/private collaborative groups have formed in the Basin over the past few years to jointly address natural resource issues. These groups, which typically strive to include a balanced range of stakeholders regarding a given piece of land, natural resource, or decision, have yielded many benefits, including opportunities for mutual learning, increased ownership in decisions, and improved agency ability to implement plans. Such groups provide models of collaboration for use in ecosystem management strategies.

On the west side of the Cascades, the Northwest Forest Plan's creation of Province Advisory Committees was a move toward a new approach to public participation. Each of the 12 Provinces created as management units for the plan has an advisory committee made up of Federal employees and members of the public. The plan also established Adaptive Management Areas that called for new forms of ongoing collaboration in the planning, management, and monitoring of public lands.

A similar effort began in 1995, when the BLM and FS formed Resource Advisory Councils (RACs), each covering a distinct geographic area in eastern Oregon and Washington. The RACs, which eventually will cover much of the western United States, are designed to make recommendations to the FS and BLM on ecosystem management, watershed planning, and other local or regional natural resource issues. The list of objectives for RACs includes collaborating in resource management across jurisdictions, promoting partnerships and working groups to develop regional solutions to management issues, assisting with educational efforts, sharing science and other information, and encouraging and supporting local groups to help implement ecosystem management.

A key aspect of these two recent efforts is that they are ongoing rather than project-specific. People have the opportunity to become more involved in the entire flow of agency ecosystem management activities, rather than having only piecemeal involvement. Because these efforts are relatively new, their success has not yet been measured, but adaptive management includes tracking public participation and the social acceptability of management actions and their effects.

Ecosystem management calls for agencies and people to work together effectively in managing resources and opportunities that cross jurisdictional boundaries. The Federal Government, state governments, local governments, and the public all have their roles—some of which may differ from roles they have had in the past. Relations

Ecosystem management calls for agencies and people to work together effectively in managing resources and opportunities that cross jurisdictional boundaries.

The upper Klickitat River in southcentral Washington. A public/private task force reached consensus on a management plan for the river in the late 1980s. Members of the group included federal and state agency employees, American Indians, loggers, ranchers, private landowners, recreationists, county commissioners, and conservationists.

A number of institutional challenges to implementing ecosystem management were identified during the course of the ICBEMP.

between county governments and the FS and BLM took on a new dimension in the Basin during the Interior Columbia Basin Ecosystem Management Project. The Association of Oregon Counties, the Washington Association of Counties, the Montana Association of Counties, and the Idaho Association of Counties created a new institution, the Eastside Ecosystem Coalition of Counties, to observe activities of the ICBEMP and communicate the interests of county governments.

The multiplicity of agencies with conflicting mandates and goals and the varieties of constituencies and legal authority, coupled with significant transboundary management questions and short timeframes, may challenge the agencies' ability to implement ecosystem management. Studies of previous cross-jurisdictional management efforts have shown that tolerance for change is critical, suggesting an approach that emphasizes incremental changes and places authority for managing change in the hands of those most directly affected. An open information flow is another key factor because the success of institutions depends in large part on learning gained from the trials and errors of past practices.

A number of institutional challenges to implementing ecosystem management were identified during the course of the ICBEMP. These include poor communication and poor understanding of the definition of ecosystem management, and questions about how to implement it without new legislation. Laws such as the Federal Advisory Committee Act may pose a barrier to some forms of desirable public participation, and aspects of BLM and FS policies and procedures such as budgeting and contracting may need modification. The money required to restore ecosystems to more productive and desirable conditions is another central issue.

Despite these challenges and complexities, there is widespread agreement that existing management of public lands in the Basin should be re-examined. The following sections summarize some of the ICBEMP science findings regarding existing conditions and trends in Basin resources and opportunities.

SOCIAL AND ECONOMIC SETTING

Human use of natural resources in the Basin is one of the major determinants of existing ecosystem conditions. The role of humans in the ecosystem has changed dramatically over time, with equally dramatic effects on the land, water, air, and other species. Human values regarding ecosystems have changed as well, as have the economic needs of an increasingly complex society.

Understanding how people relate to and interact with the environments in which they live (or in which they have interest) is an essential component of comprehending the functioning and therefore the management of ecosystems. People are part of the ecosystem, both in the sense of being another species that depends on other ecosystem components and because humans determine how ecosystems are socially defined, studied, and managed. The public and federal agencies agree that ecosystem management calls for consideration of what is sometimes called the "human dimension" of ecosystems, which includes people's traditional and changing perceptions, beliefs, and possible future influences on ecosystems.

Human Settlement

The Basin has been occupied by people for at least 12,000 years, when it is believed migration occurred across the Bering Straits land bridge from northern Asia. After continued warming conditions caused greater glacial retreat, early hunting societies diversified and began to fish and gather foodstuffs, which created localized cultural groups that followed seasonal patterns of flora and fauna to support their needs. Although the lifeways of native cultures evolved with important regional differences, the cultures of the Basin have a number of common elements and are, for this discussion, considered together.

Tribal groups within the culture area known as the Columbia Plateau possessed knowledge of the land gained over centuries of occupation. Within a yearly rhythm of seasonal rounds, specific places for fishing, hunting, and gathering became important to these groups. Favored areas for berry picking, root gathering, hunting, and the collection of other necessary materials offered a familiarity and continuity with the land and affirmed people's spiritual beliefs that their lives were orderly because of their "right" behaviors in association with it. American Indians were linked to their environment by careful observation, economic calculation, ritual monitoring, and religious explanation.

Tribal groups within the culture area known as the Columbia Plateau possessed knowledge of the land gained over centuries of occupation.

Access to major rivers was critical. The rivers provided salmon, steelhead, sturgeon,

Woman picking berries in a traditional use area.

lampreys, suckers, and trout. Fishing methods were successfully adapted to habitats adjacent to major waterfalls on the Columbia River, such as Kettle Falls, Priest Rapids, Celilo Falls, Five Mile Rapids, and the Cascades, as well as Salmon Falls and rapids on the upper Snake River.

Contrary to the beliefs of non-Indian emigrants arriving in the region in the nineteenth century, the Basin and adjoining areas were not pristine wildernesses, but ecological systems in which humans had been an active component. American Indians liberally employed fire as a tool to manage vegetation, fires that differed from those ignited by lightning in terms of seasonality, frequency, and intensity. The low-intensity, high-frequency fires set by American Indians served many purposes. They enriched forage for grazing, encouraged vegetation which provided browse for large mammals and berries for human and animal consumption, signaled other tribes or sent warnings, and were used in ceremonial events.

Lewis and Clark's expedition from 1804 to 1806 offered Euro-Americans the first glimpse of the potential of the American West, a seemingly endless expanse of land, game, and rivers that attracted adventurers, fur trappers, and homesteaders. The fur trade soon lured many newcomers; by 1820, 450 vessels had sailed into coastal

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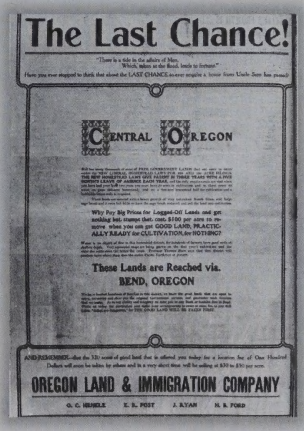
After nearly a century of policies which disposed of public lands, the Federal government began to view the remaining public domain as a storehouse which could sustain productive values.

waters to engage in it. The dominant fur trader, the Hudson's Bay Company, developed a policy aimed at trapping the fur-bearing animals of the Snake River plains to extinction in order to discourage potential competitors.

Missionaries began traveling west in search of converts, both bringing religion and promoting family-based agriculture. The 1840s brought profound change to the American West as restlessness seized a generation of Americans. Based on the success of early missions, families began making the nearly 2,000-mile trek on the Oregon Trail from Independence, Missouri, to the Willamette Valley in Oregon. During the period from 1840 to 1860, most of these overland migrants passed through the Basin en route to the Willamette Valley's greener pastures and proximity to navigable waters.

A series of Federal Homestead Acts reflected the era's Federal policy—to transfer public lands as easily as possible to citizens who could make use of them. Federally-supported railroad developments changed the shape of the West. The "checkerboard" ownership patterns of the lands in central Washington and elsewhere are a legacy of these land grants and the railroads. By the 1880s it was possible to arrive in the Pacific Northwest in five days instead of five months.



Early immigration to the Basin was encouraged through Federal policies.

The discovery of gold in 1862 drew many to the Basin. Thousands of miners flowed to the region, leading to development of towns and the infrastructure that in turn drew stock raisers and farmers. Mining towns took on an urban cast, with hotels, restaurants, general stores, blacksmith shops, sawmills, laundries, and other service businesses that supported mine workers.

Irrigation had been underway in parts of the Columbia River basin as early as the 1880s. Most of the nineteenth century projects were small, often consisting of hand-dug ditches that irrigated bottom land of 30 acres or less. Passage of the Newlands Reclamation Act in 1902 established the Reclamation Service in the Department of Interior. The Act deposited profits from the sale of western lands into a reclamation fund to support irrigation projects, allowing the Federal Government to underwrite the building of dams, canals, and ditches beyond the capabilities of communities or the private sector. This made it possible for more people to settle in the interior Basin. Cooperative ventures and Federal projects mounted by the Bureau of Reclamation grew rapidly in the twentieth century. Today, irrigation from both surface and ground water sources is by far the dominant off-stream use of water in the Basin.

The U.S. Forest Service was established in 1905 to manage a growing inventory of Federal forest reservations established to conserve resources—especially water. In Gifford Pinchot's view, the reserves could protect water supplies for irrigation and western cities, provide cheap grazing, and repay the Treasury with timber sales while contributing to national growth and the stability of local economies. After nearly a century of policies which disposed of public lands, the Federal Government began to view the remaining public domain as a storehouse which could sustain productive values.

Following on the heels of mining and agriculture, a third leg of the Basin's economy, the timber

Railroads made it far easier not only for people to reach the Basin, but for timber and other resources to be delivered from the Basin to broader markets.

industry, took off near the close of the nineteenth century. The industry paralleled development of mines and railroads—railroads needed wood for ties and trestles and created links to markets, mines needed timbers for shoring, and lumber mills needed access to the woods to extract logs.

In the early 1900s, road construction began to open the forests of eastern Washington and Oregon. Constructed mainly through river valleys, riparian areas, floodplains, and adjacent hillsides, the roads efficiently provided access but decreased the land's effectiveness as wildlife habitat and provided a new avenue for erosion and discharge of sediment into streams. In 1916, the region's first paved, rural roadway, the Columbia River Highway, opened to link the western and eastern slopes of the Cascades.

Automobile access gave people the means to travel throughout the interior Basin for recreation. In 1916, the National Park Service was created to handle the administration of the growing set of national parks and monuments. Although the

The automobile opened up a new era of tourism and recreation, in this case through an old forest of single story pine.

early parks had been promoted for local economic development, increased visitation and public sentiment to protect natural features led to the Park Service's Organic Act of 1916, mandating a mission of limited development, "...which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Grazing was another land use that took hold in the Basin, increasing the feasibility of homesteading and creating a lifestyle that remains today. In the 1920s, ranchers and others recognized that overgrazing of public lands, in combination with drought conditions, was severely impairing the ability of the land to support their operations. Impetus for initial regulations also came from Frederic V. Coville's influential *Forest Growth and Sheep Grazing in the Cascade Mountains of Oregon,* published in 1898. His recommendations led to

an allocation and permit system under which stock raisers secured grazing privileges within bounds of regulations set by the U.S. Forest Service.

The Taylor Grazing Act of 1934 brought range regulation to 142 million acres in 11 western states, removing the area from potential sale and placing it under the jurisdiction of the Grazing Service, which evolved into the Bureau of Land Management in 1946. Range improvement projects were undertaken and local advisory boards established to allocate and manage the rangelands. The condition of rangelands in the interior Basin has generally improved since then, although with slower progress in riparian areas.

Near Burns, Oregon. Turn-of-the-century cowboys around the chuck wagon.

The systematic exclusion of fire from ecosystems began in the early 1900s; fire was viewed as a threat to forests as well as to the lives and property of increasing numbers of settlers. The newly-created Forest Service believed that fires killed regeneration under larger trees, unaware of the increased problems with wildfire control and forest health. Thus while fire was being used west of the Cascades to reduce slash after logging, its general occurrence was being excluded from the east side of the Cascades where it had occurred frequently.

While this fire-exclusion policy was well-intended, the result over time was a change in forest stands from seral, fire-adapted species to more fire-susceptible species that formed unhealthy stands that were subject to larger-scale fires and increased outbreaks of insects and disease. This societal attitude, successfully perpetuated by Smokey the Bear since 1945, prevailed until the 1980s, as the role of fire as a natural disturbance came to be more widely understood.

This brief look at the history of interactions between people and other ecosystem components of the Basin explains some of the reasons why past actions were taken. This is a prerequisite not just to learning about how present ecosystem conditions arose, but to understanding the rationale behind human uses of natural resources and the basis for peoples' judgments about the acceptability of those uses and their effects.

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Basin Population Today

In 1990, just under three million people lived in the Basin. The Basin is sparsely populated; the 100 main counties in the Basin account for about 8 percent of the land area in the United States, but only 1.2 percent of the population. Nearly half the population is located in 12 of the 100 counties, although just six of these (Ada and Canyon Counties in Idaho; and Benton, Yakima, Franklin, and Spokane Counties in Washington) are large enough to be called metropolitan counties.

The age distribution of Basin residents is very similar to that of the Nation, but contains a larger proportion of people under 18 and a smaller proportion who are in the prime wage-earning years of 25 to 49. The project area contains a larger proportion of Whites (92 percent) and American Indians (2.4 percent) than does the United States (80 percent and 0.8 percent, respectively), and a smaller proportion of Blacks (0.6 percent, compared to 12 percent nationally), and Hispanics (6.7 percent, compared to 9 percent nationally).

Population growth in the project area over the last 45 years has reflected the dramatic changes occurring nationwide. Between 1950 and 1970 there was a significant out-migration from rural to urban settings; in the Basin, over one-third of the counties showed population losses. During the 1970s, Basin counties reported population increases, while the 1980s demonstrated a return to traditional urban migration and population patterns.

In the early 1990s, population growth again occurred throughout the Basin; 96 percent of counties increased in population. In addition to metropolitan counties, one type of county that showed large increases were so-called recreation counties, those in which recreation and tourism play a large role in the economy, accounting for 24 percent of the population increase in the project area (**map 5**).

Assumptions about migration rates affect estimates of future population growth patterns. A low estimate, already exceeded in many areas, results in a population by year 2040 of about 3.5 million compared with the high estimate of nearly 6.5 million. Given recent swings in population settlement patterns, it is difficult to tell with certainty which scenario is most likely. However, even though overall population density would still remain well below the national average, there is a reasonable potential for greatly increased growth.

In the early 1990s, population growth again occurred throughout the Basin; 96 percent of counties increased in population.

Map 5—Counties experiencing high growth rates.

Attitudes, Beliefs, and Values

Data from existing surveys and those conducted for the ICBEMP were used to examine people's attitudes, beliefs, and values on questions relevant to the project. This information is valuable because it suggests what aspects of ecosystem management may be the most acceptable, contentious, or confusing. They also provide the public and agency decision makers with greater understanding about why people feel the way they do.

Recent national surveys have found that a majority of the American public continues to support the environment and believes environmental issues remain a high social priority. However, support may be slightly lower than it was several years ago. People tend to believe a balanced approach to public land management is possible, but favor environmental protection over economic growth if forced to choose between the two (although many believe that the future does not necessarily involve this choice).

Attitudes, Beliefs and Values

Attitudes reflect peoples' evaluations of something as favorable or unfavorable. They can be strong and well-formed or weak and broad, and are generally developed through a variety of learning processes. Beliefs reflect what people think is true about something—a person's subjective probability that an object has one or more attributes. Values reflect the things people hold dear to them. They are generally regarded as important life goals or standards of behavior for a person, and toward which the person has a strong, positive attitude; peoples' value systems could be viewed as the building blocks of many attitudes and beliefs. Values, like attitudes and beliefs, are dynamic but are more deep-rooted and resistant to change. Part of a land manager's job lies in understanding attitudes, beliefs, and values, how they change over time, and how they influence people's perceptions of land management actions.

Support for endangered species laws and regulations remains strong among a public majority, but the public is increasingly concerned with seeking a balance between species protection and costs to society—a concern especially strong among rural residents. Support for salmon recovery and a willingness to accept resulting socioeconomic effects seems to be stronger than that for endangered species in general, although most people perceive that the major barriers to recovery are dams and over-fishing rather than lack of suitable habitat.

Disturbance events such as fire, insects, and disease have negative connotations to many people. Many people understand that these occur naturally in ecosystems, but also see the results as "a waste of good resources."

Many people say they have yet to hear a good definition of ecosystem management, and how it differs from the concept of multiple use. Many who support ecosystem management doubt agency ability or will to adequately implement it. Some clearly believe that ecosystem management is an excuse for the agencies to keep cutting timber under the guise of forest health. People who favor passive approaches to management believe

Support for endangered species laws and regulations remains strong among a public majority, but the public is increasingly concerned with seeking a balance between species protection and costs to society—a concern especially strong among rural residents.

that further human meddling with ecosystems can only lead to more unintended results. Others are simply opposed to the idea of ecosystem management for many reasons, including effects on private lands, the cost of restoration efforts, and perceived economic effects on individuals, communities, and broader economies.

Survey research suggests that the public prefers to work with the Federal agencies and others having management authority, rather than relying on legislation or court cases, to achieve mutually desirable conditions.

Survey research typically finds differences in opinions between residents of small, rural towns and residents of larger urban areas as well as the national publics in general. National samples tend to be stronger on environmental protection and less sympathetic to local economic effects than are local residents—perhaps because non-locals may share more in the benefits than the costs. Residents of small towns in the Pacific Northwest are less likely than urban residents to favor strengthening the Federal role in resource protection. However, there are many issues for which the opinions of these populations are similar, such as favoring an increased role for the public in public land management. Survey research suggests that the public prefers to work with the Federal agencies and others having management authority, rather than relying on legislation or court cases to achieve mutually desirable conditions. People often favor increasing the role of local or state government.

The institution of land and property rights, which plays a central role in ecosystem management, is a highly controversial social issue that is increasingly being defined in the courts. One aspect of this debate is the idea of "takings," based on the Fifth Amendment statement that private property shall not be taken for public use without just compensation. Advocates for private property insist that government regulations, especially those initiated for environmental protection, constitute taking because they reduce the opportunity for property to be freely used at the discretion of the individual. Another central issue is consolidation of private ownerships and the increased public reliance on Federal lands for access to valued opportunities.

One important value that has implications for ecosystem management is sense of place, which refers to how people define ecosystems and specific locations in the landscape based on their meanings and images. Recreation visitors develop attachments to places based on their past experiences—meanings that often pass from one generation to another. People who make their living from public land resources and opportunities typically develop close relationships to places on the land. Community residents and other social groups tend to develop collective definitions of places that are socially important, providing a stronger sense of community.

The concept of place has not been widely or uniformly used by Federal land management agencies, yet the task of defining places has proven to be a positive process, both involving community residents and spurring discussion about common visions for public land management.

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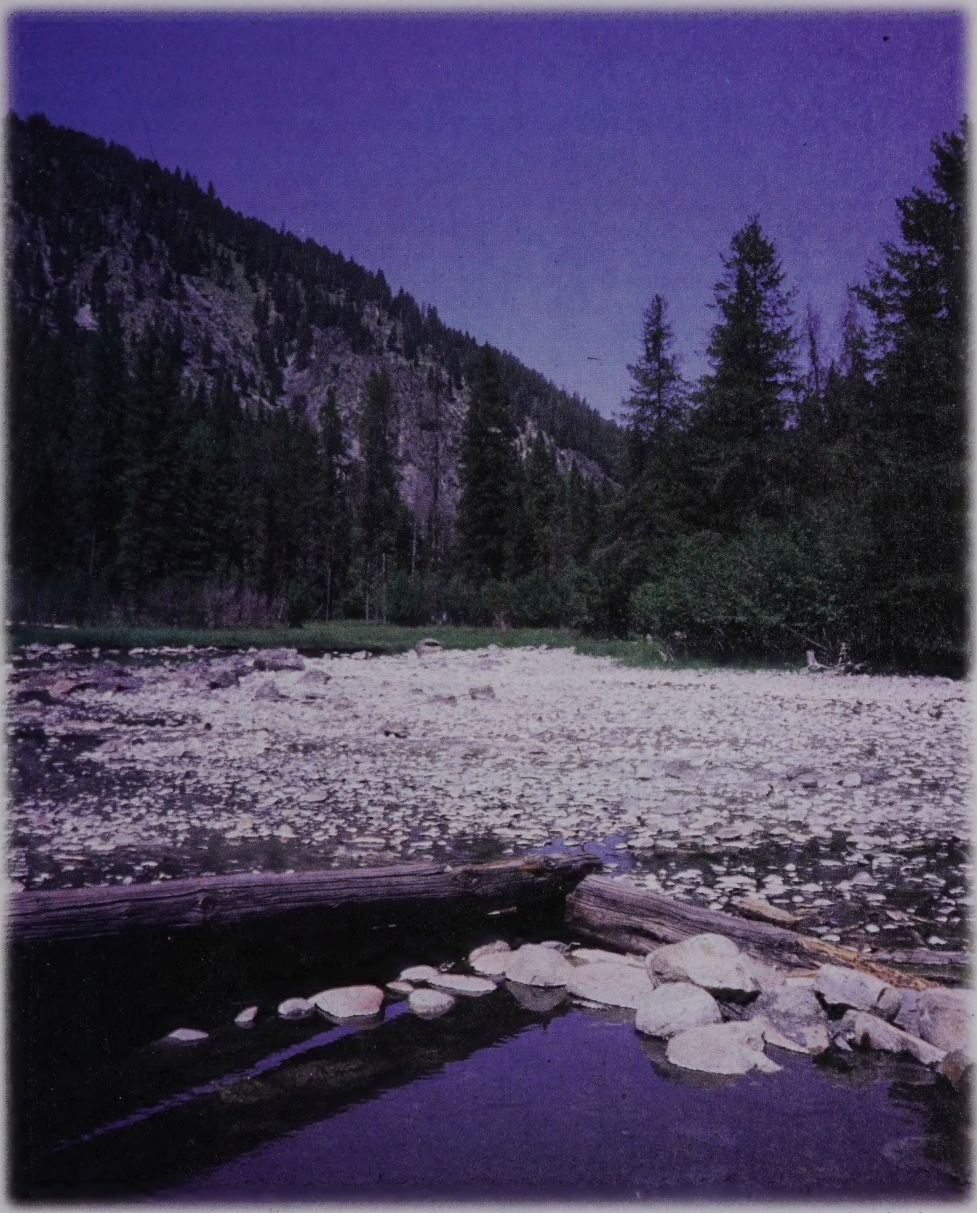


Based on their experiences, people attach meaning to places in the landscape. Attachments can develop that last through generations at places such as this hot springs near Sheep Creek in central Idaho.

Existing Benefits of FS- and BLM-administered Lands

A fundamental tenet of land stewardship is for managers to direct and maintain ecosystems to fulfill the objectives of the owners. For the FS and BLM, providing a broad array of ecosystem goods, functions, and conditions is appropriate because it is required by laws and regulations and because demands from their constituencies are extensive and diverse. The economic challenge of ecosystem management for these agencies is threefold: to produce the bundle of ecosystem goods, functions, and conditions that society wants (economic efficiency); with a distribution of benefits according to societal wishes (equity); and without adversely affecting economic activity.

Economic Efficiency

Under current management, FS- and BLM-administered lands in the Basin provide society with a wide array of benefits. The current and future importance of selected benefits that could be measured and valued is shown in **table 1**. Of the outputs and conditions evaluated, the existence of unroaded areas is a highly valued condition on FS- and BLM-administered lands in the Basin today. Projections indicate that it will continue to be so in the year 2045, although to a lesser degree. The Basin contains 70 percent of the unroaded areas of 200,000 acres or greater in the United States (outside Alaska).

Projections indicate that by the year 2045 the three most highly valued uses will be motor viewing, day use, and trail use. This suggests that the objectives of land management activities might be different in the year 2045 than they are today. For the Basin as a whole, the relative importance of wildlife viewing, motor and non-motor boating, range, off-road vehicle (ORV) use, and snowmobiling provided by FS- and BLM-administered lands are included in the category labeled "other" (table 1).

Broad indicators suggest that forest acreage and inventory at the Basin-wide level are being sustained. Given current levels of recreational activity and harvest, publicly grown Christmas trees, firewood, mushrooms, and berries, as well as some other Federal resources face potential overuse. Because these valuable resources are available to the public at little or no cost, there is little incen-

Table 1—Current and future benefits.

Activity	1995 Value	2045 value
	..... percent	
Camping	3.45	4.40
Day Use	5.28	8.11
Fishing	9.88	6.64
Hunting	9.48	6.31
Motor Viewing	1.88	9.46
Timber	11.49	5.38
Trail Use	3.28	6.85
Existence value of unroaded areas	46.86	41.43
Winter Sports	5.05	5.70
Other	3.35	5.72
Total	**100.00**	**100.00**

tive for users to conserve them. The increases in human population predicted for the Northwest suggest that demands on ecosystems and public resources will continue to increase. Establishing a fee system for recreation and special products could protect ecosystem conditions in recreational settings, maintain sustainable or harvestable levels of species, and provide new sources of revenue.

The increases in human population predicted for the Northwest suggest that demands on ecosystems and public resources will continue to increase.

Equity

The benefits of FS- and BLM-administered lands in the Basin are distributed widely. Consumers of beef or timber benefit because these goods are traded in national markets. People who enjoy knowing unroaded areas exist and who may never visit the Basin also receive benefits. Millions of people, mostly residents of the Basin and the Northwest, recreate here; there is little difference in participation rates among people with different lifestyles.

About 220,000 jobs are associated with current levels of range, recreation, and timber harvest on FS- and BLM-administered lands. Range accounts for 1 percent of these jobs, recreation 87 percent, and timber 12 percent. In addition, jobs are associated with mining and the harvesting of special forest and range products, but the exact number is unknown.

Federal distributions to county governments from revenue sharing are currently determined from timber sales and grazing permits. Yet some of these counties bear costs associated with recreation—infrastructure, road maintenance, and emergency services, for example. If the value of recreation on Federal lands was included in payments to counties, it could double or triple their revenues.

Economic Activity

The Basin—Agriculture and agricultural services remain economic strengths of the Basin. The Basin has a large, diverse economy of 1.5 million jobs that is enjoying above average rates of growth. Per capita income is growing faster than the U.S. rate, and the poverty rate is generally lower than the national average. The past decades have seen rapid population growth, and the evolution of what was a mature, resource-based economy into a diverse economy oriented toward the technology, transportation, and service sectors (table 2).

The relative importance of various sectors to the size of the Basin economy and its buying power include grazing (1 percent), mining (0.5 percent), recreation (15 percent) and timber (3 percent). The recreation counties have higher per capita income than manufacturing counties, indicating they are areas of higher economic well-being and fiscal capacity.

General economic growth in the Basin is expected to continue, sustained by in-migration in some areas. Growth is expected in services, finance, insurance, real estate, trade, and agricultural services. Fastest growth is expected in the service sector, which includes health, business, educational, and legal services. The manufacturing, farming, and government sectors are expected to decline as a percent of the economy over the next 50 years.

The past decades have seen rapid population growth, and the evolution of what was a mature, resource-based economy into a diverse economy oriented toward the technology, transportation, and service sectors.

Table 2—The relative employment contributions by selected economic sectors comparing the Nation with the Basin (percent of 1.5 million jobs in 1995):

Sector	Nation	Basin Average
	percent	
Agriculture services	1.14	2.56
Mining	0.66	0.45
Construction	5.20	4.65
Manufacturing	14.11	11.71
Transportation	4.76	4.30
Trade	21.49	21.14
FIRE (financial, insurance, and real estate industries)	7.53	6.00
Services	28.38	25.02
Government (all)	14.57	16.39
State and Local	10.44	12.18
Federal	4.13	4.21
Farm Employment	2.16	7.78
Lumber and Wood products (subset of Manufacturing)		2.52
Range (subset of Farm employment)		1.01
Recreation (subset of Trade and Services)		15.00

Traditional regional economics views growth as a function of expansion in basic manufacturing industries. Contemporary challengers argue that other industries should be considered to be part of the economic base. The ICBEMP assessment findings indicate that changes in management strategies by the FS and BLM have little effect on the economy of the Basin or its subregions using either of these two approaches. However, the effects of the agencies may be more pronounced at specific local levels.

The nine regional economies in the Basin as described by the Bureau of Economic Analysis (BEA) are diverse, and thus resilient to changes in FS and BLM commodity outputs. Overall, the forest products industry has had a neutral effect on recent economic growth. Analyses found no relation between economic well-being at the county level (expressed as per capita income) and either the forest products processing facilities or the presence of timberlands—whether Federal, FS only, or private. Basin-wide, the cattle industry accounts for 29 percent of agricultural sales, but only 7 percent of the cattle industry is dependent on BLM and FS forage. Recreation accounts for 14.6 percent of the jobs in the Basin. Mining accounts for 0.5 percent, with an uncertain proportion attributable to FS and BLM resources.

Counties—The county is also a critical unit for economic analysis. Counties grouped according to a typology of income specialization or other characteristics exhibit different patterns of economic behavior. Those dominated by the service sector have consistently shown the highest rates of economic and population growth since 1970; they have also exhibited high resiliency, rebounding faster than other counties after the early 1980s recession. These include counties with trade-center

Rural community. This is a landscape dominated by a rural community in a plains (or valley) environment, surrounded by agriculture, range, and forest. Humans have typically settled in the most productive areas that have available water and are close to the foothills and mountains. This often results in conflicts between humans and the wildlands that surround their communities.

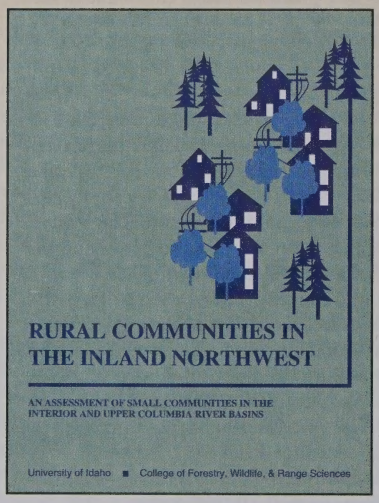
towns, and growing recreation and tourism economies. Counties dominated by recreation or retirees have shown consistently high rates of growth in population, total employment, and total personal income over the last 20 years. Between 1979 and 1989, counties in which manufacturing income is dominant showed the highest tendency to evolve to a different kind of economy. Many of these did so because of losses in the wood products or mining sectors.

Communities—The Bureau of Census recognizes 476 communities within the project area, including 29 cities larger than 10,000 in population and 49 Census Designated Places—locations that are unincorporated but have an identity to the local population. Of the other 398 small rural communities, 68 percent are communities of 1,500 or less (the smallest size class). These range from 22 to 1,500 in size, with an average population of 520.

The status of communities within the Basin is defined in terms of their capacity to adapt to change. This ability, termed "community resiliency," is a function of economic structure, physical infrastructure, civic leadership, community cohesiveness, and amenities. Information collected about community conditions included employment profiles of nearly 400 communities in the Basin with less than 10,000 people to develop local indices of economic diversity. **Figure 3** describes employment by sector for the Basin's rural communities of 10,000 or less.

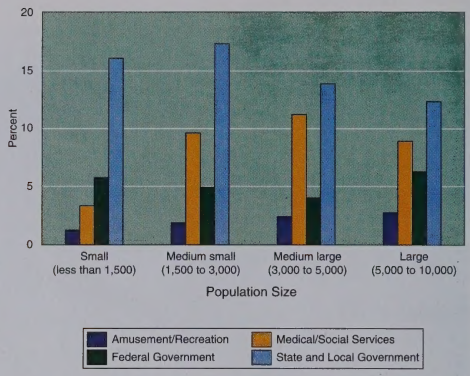
Communities

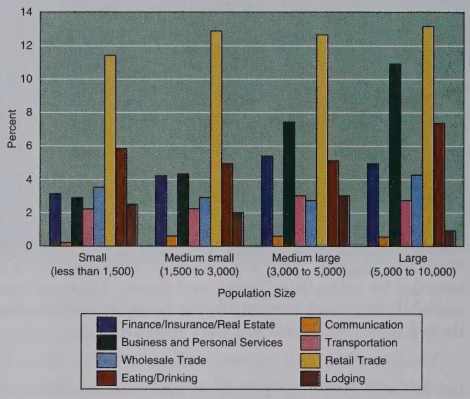
Community is an important scale for ecosystem assessments because communities are where people socialize, work, shop, and raise their children—the focus of their social lives. In public meetings conducted by the Science Team and in scoping and other meetings held by the EIS teams, people repeatedly expressed concern that conditions and functions of communities and related places used and valued by residents be identified and considered alongside other ecosystem components. For the ICBEMP, many types of information about Basin communities were collected, particularly for those with populations less than 10,000. An important source of primary data was a series of Community Self-Assessment workshops—interviews with 1,350 community leaders and residents held in nearly half (198) of the Basin's small communities. In addition, a profile of the economic structure of each community was developed, because social and economic conditions in communities are intertwined.

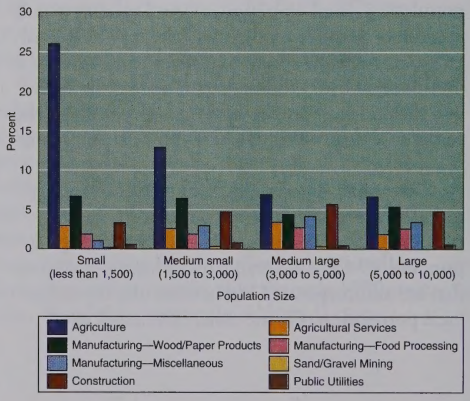

RURAL COMMUNITIES IN
THE INLAND NORTHWEST
AN ASSESSMENT OF SMALL COMMUNITIES IN THE
INTERIOR AND UPPER COLUMBIA RIVER BASINS
University of Idaho ■ College of Forestry, Wildlife, & Range Sciences

Self-assessment workshops were held in nearly half of the Basin's small, rural communities.

Figure 3—Employment profiles by size of community.







Shaniko, Oregon, not all that different from how it looks today. Some towns are resilient by virtue of their small size and social cohesiveness.

Agriculture dominates the smallest towns, but more surprising is the relative diversity present across communities of all sizes. Wood/paper products manufacturing, retail trade, state and local government, and eating/drinking sectors all contribute substantially regardless of community size. The role of some sectors, such as business and personal services, increases with community size. The community workshops showed that people tend to underestimate the diversity of their local economy and overestimate the importance of traditional industries.

However, the economy is just one component of overall resiliency. In general, more-resilient communities tended to be larger, more autonomous, be rated by residents as having a local government responsive to the public, and have plans for dealing with change—as well as having an economy based on a mix of industries. The data suggest that there is no one common formula for achieving community resiliency; many strategies have proven successful. Natural resource dependent communities that have been confronted with significant challenges are among the most resilient because they have successfully learned how to deal with change.

Analysis of data gained through the community self-assessment workshops suggest that it is useful to think of three types or groups of communities with respect to resiliency. The first group has the highest scores on all five of the community characteristics that contribute to resiliency; these are communities viewed by their leaders as attractive, economically diverse, socially cohesive, and having

strong civic leadership. These communities also tend to be larger in population and exhibit the greatest economic diversity. This group tends to contain a larger number of communities than the other two groups. These communities presumably have a number of different characteristics that will allow them to meet new challenges successfully.

The second group of communities has comparably high scores on civic leadership and amenity values, but much lower scores on social cohesion and economic diversity. Towns in this group have considerably less population than those in the first group. The number of towns in this group is slightly lower than the number in the first group. This type of community may lack the economic base to deal with change successfully, but this could be compensated for by forward-thinking civic leaders and the presence of amenities.

The third type of community tends to have the lowest scores on all of the measures (although scores on amenities were only slightly lower). They are intermediate in population (though closer in size to the smallest rather than the largest towns). These communities may find it difficult to cope with change because they have few current strengths on which to build. From a Basin-wide perspective, this group is by far the smallest, containing just a handful of communities.

The community is an important level of social analysis, but within communities there are many different sociocultural groupings that could be affected differently by ecosystem management programs and activities, such as occupational groups that have identities strongly tied to natural resources. These are sometimes referred to as "communities of interest." Changes in public land conditions and outputs can have many significant effects on the quality of people's lives, even if they live in a resilient community.

Characterizations of Specific Resources

This section focuses on some of the economic sectors most closely related to management of FS and BLM lands, and begins with historical descriptions of those economic sectors initially most important to settlement of the Basin.

Fish

When Euro-American settlers arrived during the early 1800s, salmon were abundant and diverse. Spawning runs of chinook salmon made their way up the mainstem Columbia to the Snake River, and then up to the headwaters of the Owyhee and Bruneau Rivers and Salmon Falls Creek as far as Nevada.

Estimates of historical run size for all species of salmon and steelhead in the Columbia River range from 10 to 16 million adult fish. Not only was their course unimpeded by dams, but ample suitable habitat to support these populations existed. Fur trappers and traders reported extensive stands of willows and alders, and wide, wet meadows along stream systems throughout the interior of the Columbia River basin. The Ochoco Mountains take their name from an American Indian word meaning "streams lined with willows."

Commercial harvest began in earnest when the first cannery began operating on the Columbia River in 1866 and soon exceeded sustainable levels. Commercial catches of chinook salmon in the Columbia peaked in 1883 when about 43 million pounds of fish were landed. Coho, sockeye, chum, and steelhead also were abundant in the Basin. Catch of coho peaked at 6.8 million pounds, and catch of sockeye and steelhead peaked at 4.5 million pounds in 1895. By the late 1800s, overfishing was blamed for broad declines in chinook salmon runs. By 1900, certain fishing gear was banned to protect spawning runs, but the effects from mining, timber harvest, livestock grazing, and agriculture had begun.

Dams such as this one provide irrigation, while others generate hydropower. However, they are now part of a societal debate due to their impact on fish habitat and populations.

New Deal programs were critical in sustaining and building infrastructure in the interior Columbia River basin. The river's mainstem dam construction began with the Bonneville Dam in 1938 and the Grand Coulee Dam in 1942. Later, however, the debate over dams came to symbolize new types of emerging social values. After World War II, as more citizens were affected by environmental changes, grassroots action and citizen demands began to bring environmental values to the forefront. This set the course for conflict between forces associated with large-scale management and technology and those emphasizing protection of environmental quality. This change was symbolized by debate over dams in Hell's Canyon, which shifted from who should build them, and how many, to the possibility, voiced by Supreme Court Justice William O. Douglas, that maybe the river had greater value in its free-flowing state.

The net result of these and a multitude of other actions has been the virtual elimination of a valuable commercial fishery. It has also meant incalculable damages to American Indians for whom salmon was a significant part of their economic, cultural, and spiritual lives. The FS and BLM are managing much of the last remnants of good quality habitat for declining fish stocks. The burden on the FS and BLM to maintain habitats that support strong fish populations will probably increase with human population growth and climatic influences on ocean habitat.

Map 6—Status of mines and deposits.

Minerals

Coal deposits had been reported as early as 1833 by an employee of the Hudson's Bay Company, and significant base metal and silver lodes were discovered in eastern Washington during the late 1800s and early 1900s. But it was the discovery of gold that drew many to the Basin. In 1862, several placer deposits were announced, including deposits on the John Day River near Canyon City, Oregon; at Florence, Idaho, on the Snake River; and at Pierce City and Orofino, Idaho, on the Clearwater River. Strikes in the Boise basin and other locations would soon follow. Thousands of miners flowed to the region, leading to development of towns and the infrastructure that in turn drew stock raisers and farmers. The General Mining Law of 1872, following the precedent of the Mining Law of 1866, opened minerals on public lands to all. Mining practices of the nineteenth century also established the logic behind western water law—first in time, first in right.

Mining practices of the nineteenth century also established the logic behind western water law—first in time, first in right.

Currently, the Basin produces 30 percent of the nation's silver, 12 percent of the nation's phosphate, and 11 percent of the nation's gold. There is a smaller percentage of mining employment in the Basin than nationally (0.45 percent versus 0.66 percent), but mining is very important in six of its counties.

Future mineral production will depend on metal prices, laws, and regulations rather than on changes in FS or BLM management practices. The extent to which mining activity will affect public lands is difficult to predict (**Map 6**). The greatest probability for mineral development in the long term is along three geologic trend-lines. One is a northeasterly trend from southeastern Oregon into central Montana in which the most economically attractive targets include copper, cobalt, and large, low-grade deposits of gold and silver. In the western Northern Glaciated Mountain and North Cascades areas, mining for gold and silver will likely continue—first underground and then in open pit mines. Considerable base-metal resources lie in a northwesterly trend from southwestern Montana into northeastern Washington. Large-scale open-pit mining and processing of phosphate ore is likely to continue in the Snake Headwaters and Upper Snake regions over the long term.

Grazing

Historically, a wide variety of ungulates, including deer, elk, mountain sheep, antelope, and bison occurred in eastern Washington and Oregon. Natural predators kept the numbers of ungulates in balance. These animals had wide ranging mobility, and their grazing and browsing were linked with the vegetation cycles within the Basin. Bunchgrass and other native vegetation in Basin plant communities are stimulated by disturbance from grazing, and plant abundance can be enhanced.

The widespread presence of bunchgrass initially attracted itinerant herders that could walk their stock to markets. By the 1870s the goal of most ranchers was to secure a base of operations with dependable water supplies and the ability to cut and store sufficient hay to feed livestock during the winter—a base which has sustained many cattle operations to the present day.

As Euro-American settlement began, not only were many predators displaced, but sheep, and then cattle, were introduced in numbers large enough to result in overgrazing. By 1860, 200,000 cattle were settled in Oregon, along with sheep and wild horses; the grazing practice of the time was year-round open range. Anecdotal reports and photographs showed summer ranges

Wild horses on the range in eastern Oregon.

so laden with sheep that they appear to be snow drifts. Fescues and other bunchgrasses were irreversibly modified by extensive grazing in the late 1800s and early 1900s.

Overgrazing damaged stream and riparian vegetation in many basins in eastern Oregon and Washington. Overgrazing also facilitated the spread of annual cheatgrass and reduced vegetation that had provided fuels for fires. When combined with later fire-suppression efforts, the result was reduction of an important ecosystem disturbance. Another critical factor was climate, particularly drought, which affects how vegetation responds.

Cattle have dominated livestock production throughout the Basin at least since the first collection of agricultural data in the Census of 1870. The number of cattle grew steadily throughout the twentieth century to 4.1 million in 1969, a level that has remained relatively constant. Horses and sheep also played an important role in livestock operations in the Basin, although their importance dropped significantly after the 1930s.

Currently, the BLM accounts for 45 percent of the 2.9 million Federal animal-unit months (AUMs) of forage in the Basin, with the FS providing the other 45 percent. The dependency of the livestock industry on BLM and FS forage varies from 1 to 11 percent in the BEA regions, with a Basin-wide average of 7 percent. Sales of cattle dependent on BLM and FS forage average 2 percent of total agricultural sales across the Basin. Analysis at the county level shows relatively few counties (seven) that rely on FS or BLM lands for 1/3 or more of their grazing acreage, while 67 counties had less than 10 percent reliance on FS or BLM forage.

If current trends continue, forage use will decrease on BLM lands by 18 percent, and on FS lands by 19 percent, over the next two decades. On average, holders of BLM or FS grazing permits run bigger operations that are more profitable than those of non-permittees. The largest permit acreages and AUMs are skewed toward the largest permit holders—held by a small number of individuals, corporations, and partnerships.

Recreation

Environmentally-based amenities managed by the Federal Government play many social and economic roles in the Basin; they contribute to the quality of life of Basin residents; attract new migrants; and provide recreational settings for residents and non-residents. FS- and BLM-administered lands in the Basin provide over 200 million recreation activity days per year, valued at $1.0 billion per year (in terms of willingness-to-pay). At present, recreation on FS- and BLM-administered lands has a higher willingness-to-pay value than the market value of timber or range outputs across the Basin, except in the Klamath Basin area where projected timber values will be surpassed by projected recreation by the year 2005. Fishing provides the greatest benefits of all activities ($300 million), followed by day use ($250 million), downhill and cross-country skiing ($230 million), hunting ($146 million), and camping ($75 million). By the year 2045, the most value to the increasing and older human population will be provided by (in decreasing order) motor viewing, day use, trail use, fishing, and hunting.

The FS and BLM manage over 90 percent of the federally owned recreation acres in the Basin. The Basin's abundant unroaded areas are an irreplaceable national resource; about 40 percent of the Federal lands in the Basin provide primitive or semi-primitive recreation opportunities.

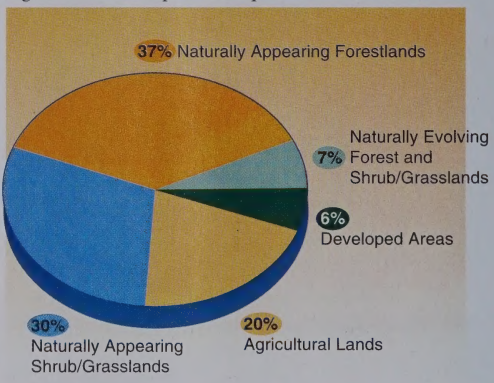
Seventy-five percent of all activity days take place in roaded natural settings (road densities between 1.7 and 4.2 miles per square mile). Roads and access to riparian areas are an aspect of recreation common to what will likely be the most highly valued recreation activities for the next 50 years. If charged, recreation fees could be used to finance road maintenance, and to offset other potential decreases in road funds.

A tradeoff exists between access for some types of recreation and primitive/semi-primitive recreational settings for others. In the lower 48 states, 70 percent of the unroaded areas of 200,000 acres or greater lie in the Basin; 56 percent of trail use in the Basin takes place in the primitive/semi-primitive settings. An appropriate balance between roaded natural and primitive/semi-primitive settings is a question that needs further study.

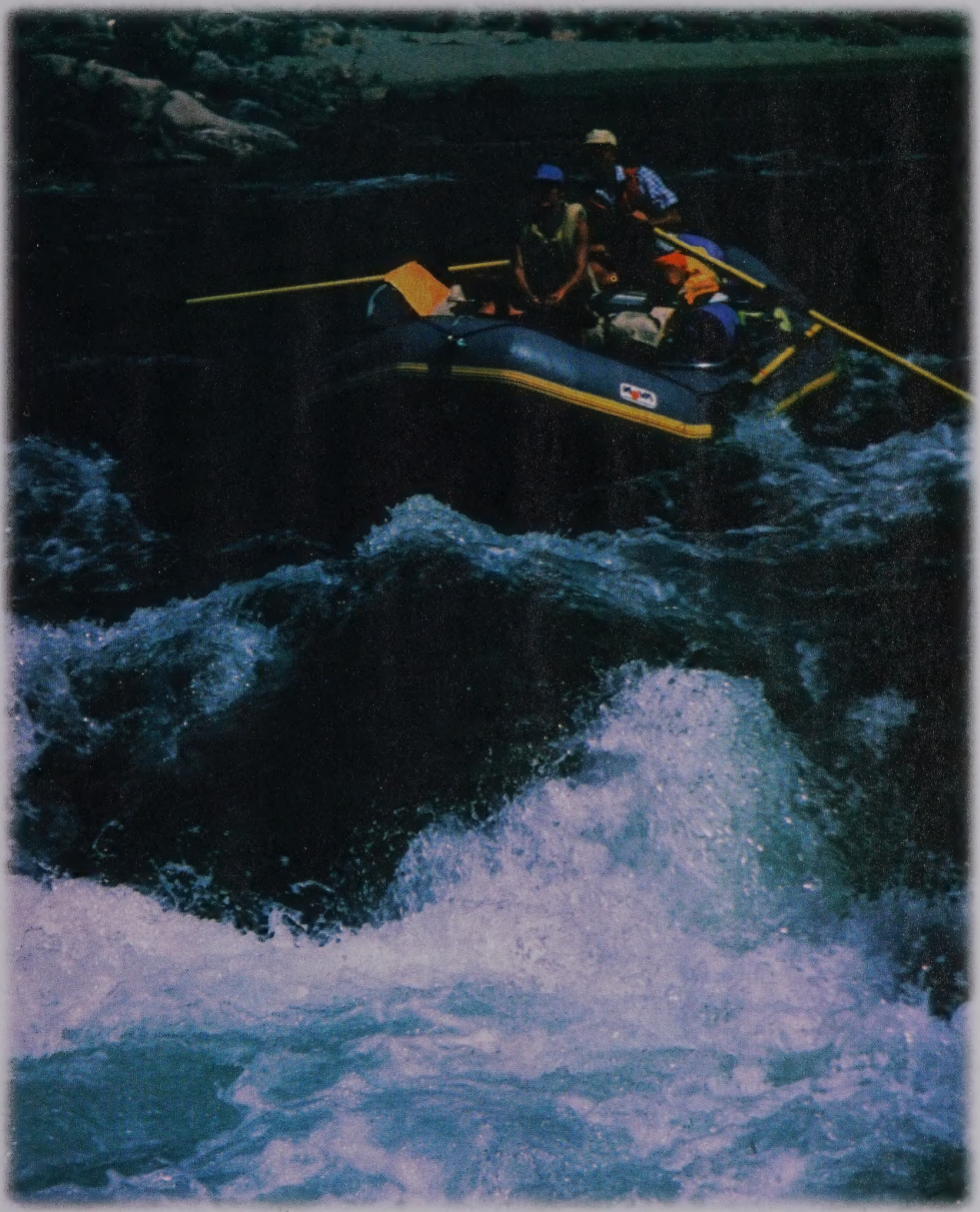
Purchases of food, equipment, lodging, transportation, licenses and other items associated with recreation on public lands add up to significant expenditures and support some 220,000 jobs in the Basin.

Landscape appearance and scenery are also important environmentally-based amenities, not just as settings for recreation, but as components of the Basin's image both to residents and non-residents. The supply of scenery in the Basin is measured in terms of landscape themes and degree of scenic integrity. The five themes used to describe project area landscapes are Naturally Evolving Forest and Shrub/Grasslands, Natural Appearing Forest Lands, Natural Appearing Shrub/Grasslands, Agricultural Lands, and Developed Areas. Just over 1/3 of the Basin currently is in Naturally Appearing Forestlands, and just under 1/3 is in Naturally appearing shrub/grasslands; of the remainder, the largest proportion is in agriculture (**figure 4**).

Figure 4—Landscape themes present across the Basin.


37% Naturally Appearing Forestlands
7% Naturally Evolving Forest and Shrub/Grasslands
6% Developed Areas
20% Agricultural Lands
30% Naturally Appearing Shrub/Grasslands

The Basin's abundant unroaded areas are an irreplaceable national resource; about 40 percent of the Federal lands in the Basin provide primitive or semi-primitive recreation opportunities.



Middle Fork of the Salmon, central Idaho. River running is one of many activities for which management has attempted to balance providing public opportunities with protecting the quality of the experience and the environment.

The Snake River in Hells Canyon National Recreation Area is a scenic landmark of regional and national significance.

Scenic integrity is reflected by the "visual intactness" or wholeness of the landscape. It was represented by combining data on vegetative structure, landform, and road density. Scenic integrity is not the same concept as scenic beauty, but research demonstrates that people often equate the two when perceiving conditions on public lands. Scenic integrity was described using five categories ranging from low to very high. Less than 1 percent of the acreage administered by the FS or BLM was rated as very low in scenic integrity, 7 percent rated as moderately low, 17 percent as moderate, 33 percent as high, and 42 percent as very high; less than 1 percent was not classified (**figure 5**).

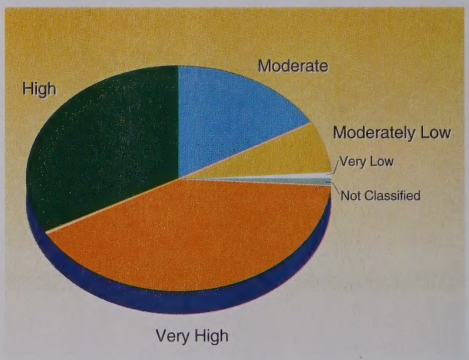


Figure 5—Scenic integrity present across the Basin.

Special Forest and Range Products

Little is known about the special forest and range products industry in the Basin because data on jobs and harvest are not regularly gathered. Relative to west of the Cascade mountains, the industry in the Basin is small but growing and focused around wild edible mushrooms and huckleberries. Rapid expansion in the special forest and range products industry in the Basin is expected to continue. Under the present permitting system and without a fee system, some of these species may be over-harvested.

Timber

By 1900, forests in the upper Midwest were nearly exhausted, and the northern interior Columbia basin became the focus of a new scramble for wood supplies. The rapid increase in harvest was reflected in Idaho, where 65 million board feet of lumber were cut in 1899. By 1910, Idaho produced 745 million board feet and its markets had shifted from local to national. Idaho employment of loggers, rafters, or sawmill workers increased from just over 300 in 1880, to more than 8,000 in 1920, and to 14,900 in 1995.

Early harvesting concentrated on the largest trees of the more important commercial species (ponderosa pine and western larch) because smaller stems could not be processed efficiently. Eastern markets in particular demonstrated a preference for ponderosa and Idaho white pine, leading to select cutting where other species in mixed forests were left standing.

Growth of the timber industry continued in subsequent decades, driven by demand for wood products in growing urban centers, especially in the Midwest and California. Development of the skidder, caterpillar tractor, log truck, and chain saw increased the efficiency of the industry, lowered costs, and increased production dramatically. The timber industry, like other industries, took many people on a roller coaster of fortune and misfortune.

From 1945 to 1970, timber harvest on Federal lands in the Basin increased about 5 percent per year, or 50 percent faster than the growth of the national economy. This increase was important to the expansion of softwood and plywood production in the western United States, supporting many western communities. Nationwide, harvest volume from FS lands increased from 4 billion board feet in 1950 to 11.4 billion board feet in 1970; 90 percent of this came from western National Forests, and 41 percent from Washington and Oregon.

Rivers were commonly used to float logs closer to the mill.

Currently, softwood timber harvest in the United States is projected to increase by 35 percent (0.6 percent per year), to 14.6 billion cubic feet by the year 2040. Since 1990, Federal harvests

Timber harvest in the Basin currently accounts for 10 percent of total United States harvest, down from 17 percent since 1986 and expected to decline to 5 percent by the end of the decade.

have declined in the West; other regions, including Canada, have increased their shares of the U.S. market. In the Basin, 38 percent of the timberland is privately owned, and another 53 percent is administered by the FS or BLM. The national forests contain 89 million acres of commercial forestland and the BLM oversees management of about 6 million acres. Timber harvest in the Basin currently accounts for 10 percent of total United States harvest, down from 17 percent since 1986 and expected to decline to 5 percent by the end of the decade. Public harvest is currently 46 percent of total harvest in the Basin.

In recent years, the number of timber jobs in Idaho and Montana has slightly declined due primarily to technological improvements. Between 1985 and 1995, the number of timber industry jobs declined from 8,400 to 7,300 in Montana, but increased from 13,600 to 14,900 in Idaho. No such trend exists for eastern Oregon and Washington. Based on current harvest projections, modest employment declines are projected to continue due to related declines in timber harvest. More than 80 percent of the timber harvest in the Basin occurs in four economic areas—Spokane, Washington; Missoula, Montana; and Redmond-Bend and Pendleton, Oregon; this includes both private and public timber.

Much discussion in past years has focused on communities having high rates of employment in the timber industry. Maintenance of stability in timber-dependent communities is often thought to be the responsibility of the FS despite their having no specific legal mandate to do so. No facts document a link between sustained timber flow and community stability.

In 1987, the FS identified 66 Basin communities as timber-dependent. Today, 29 exhibit characteristics indicating their sensitivity to Federal timber sales. These are isolated communities separate from fast-growing populations and economies in the Basin. Communities in the Clearwater Valley of Idaho are an example of towns in such regions. Federal policies toward such communities are more accurately viewed as political, not economic, reflecting political preferences about equity or distribution of wealth. Given that human populations in the Basin are expected to double over the next 50 years, the notion that any community may maintain stability is questionable. The more appropriate question is, "What attributes of communities and their economies contribute to quality of life and best accommodate change?"

High wheel logging near Bend, Oregon circa 1922.

Implications for Ecosystem Management

Peoples' uses and perceptions of Basin resources have changed dramatically in a relatively short time period. Initially viewed by Euro-American settlers as unpriced, seemingly limitless supplies to be disposed of efficiently, many natural resources are now increasingly scarce and subject to highly competing uses. Federal laws and policies regarding resource use reflect the changes in both the supply of resources and public perceptions of their values. The industries that led to settlement and infrastructure development of the Basin—mining, timber, ranching, and transportation—still play critical roles in the social and economic functioning of Basin ecosystems, but those roles have changed with time and new industries have grown tremendously.

The rapid growth in the Basin's population presents major challenges to the Bureau of Land Management and Forest Service. Recent and projected population growth is most dramatic in metropolitan areas and locations with high levels of environmental amenities. In these areas, the growth and consequent development threaten the qualities that make such places attractive for recreation, retirement and new businesses. At the urban-wildland interface, where such growth is most dramatic and development most visible, habitat fragmentation and fire protection are critical issues.

The relationships between public land management and the resiliency of small, rural Basin communities continues to be a critical issue. The current pace and nature of changes in the Basin suggest that the manner in which the Forest Service and BLM interact with communities be carefully reviewed. Old patterns of behaviors that characterized land management priorities may no longer serve the interests of many community residents. Policies to promote community stability may be inappropriate under conditions where there is little stability to be found in the social system. Economic analyses may be important to conduct not just at the regional scale but at a county and community scale as well. Each level of analysis has its own most appropriate uses, but a different story is told at each scale—each a crucial part of the ecosystem at that scale.

People are seeking to define a variety of roles in decision-making and methods of making sure their concerns are heard and treated fairly.

For example, at the Basin-wide or BEA region scale, economies are diverse and growing, but that growth is not shared equally among all communities in the larger regions, nor among all natural resource industries and the people within them. At larger scales, actions taken by the Forest Service or BLM have little effect on regional economies, but this is not the case at the community scale. Multiple factors play into the economic status of individual communities—including many that are not determined by the agencies, or even by community residents themselves. This has led in many cases to perceptions that a community's future is outside its control, but a growing number of Basin towns or groups of towns are dealing with this by developing strategic plans and visioning processes to become more economically diverse and socially cohesive.

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The future of small, rural communities, both in the Basin and elsewhere, depends on a combination of factors, some within and some outside of the control of local residents.

Environmentally-based amenities managed by the Federal Government play many social and economic roles in the Basin. Despite the importance of amenities such as recreation opportunities and scenery, systems to map and inventory these values and requisite funding are not well integrated into current agency planning systems at ecoregion scales.

The public is assuming a more active role in public land management, whether or not the opportunity is provided by the Federal Government. People are seeking to define a variety of roles in decision-making and methods of making sure their concerns are heard and treated fairly. Natural resource agencies frequently find themselves in situations where goals of resource management are contended, with a variety of potential futures described by conflicting groups.

The emerging issues represent differing values regarding what benefits society should receive from public lands. At the same time, people are looking to science to provide many of the answers and seem willing to trust credible analyses of existing conditions and potential cures. People show a willingness to trust the results of scientific study of ecosystems, but they have varying levels of trust in scientists employed by different institutions. There is recognition that science can provide many types of data and analyses, but people and the institutions we have created make decisions about how to use those findings.

There is recognition that science can provide many types of data and analyses, but people and the institutions we have created make decisions about how to use those findings.

Field trips are a particularly effective technique for establishing dialogue to gain a common understanding of ecosystem issues.

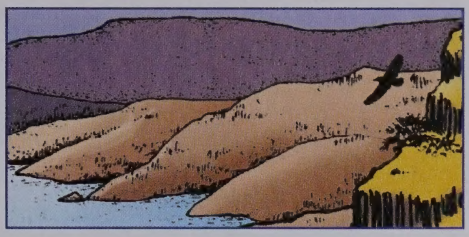
many types of data and analyses, but people and the institutions we have created make decisions about how to use those findings. Ecosystem management's explicit attempt to blend science and values is both its strength and one of its greatest challenges.

In addition, there is often little agreement about cause-effect relationships; forest health is an example of a debate among scientists about the causes and effects of forest decline. In these situations, collaborative learning processes may be more suitable as a planning paradigm than other techniques. Public participation procedures for ecosystem management could focus on learning, recurrent interaction among participants, and increased opportunities for working through complex problems to identify possible solutions. Perhaps one of ecosystem management's functions will be to clarify the role of the public in public land management.

Finally, ecosystem management may require review of the adequacy of existing institutions to support successful implementation. Institutions such as laws and procedures for conducting and evaluating public participation programs, coordinating across jurisdictions, and even conducting internal agency procedures may need to be re-examined. This societal examination of institutions, and how it is conducted, is expected to be a key factor in determining the success of ecosystem management.

Kootenai Falls in northwestern Montana is of utmost significance to the Kutenai Indians, who believe that the Creator and his divinities reside there. The Falls area has been a vision questing site for generations.

AMERICAN INDIAN PEOPLES



This section focuses on American Indians in the Basin, their relationships with the natural environment, and trends regarding agency relations with the project's affected American Indian tribes. These topics have particular significance for Federal land managers for two reasons: (1) Forest Service and BLM management actions affect resources and areas of concern to American Indians; and (2) the Federal Government holds certain trust responsibilities and obligations to tribes based on various legal agreements, including treaties, which have implications for ecosystem management. There is a great deal of overlap between issues expressed by American Indians and those voiced by the general public regarding ecosystem management. However, the legal status of American Indians, the sovereignty of tribal governments, and the nature of reserved tribal rights merits separate attention. There are 22 federally recognized tribes and a number of off-reservation traditional Indian communities that have interest in lands within the ICBEMP assessment area.

The intense interest of Indian peoples and their tribal governments in the region's ecosystems and natural resources is founded in their long-term relationship with and spiritual attachment to the land. Although various Indian societies in the region differ in many ways, they hold a common belief about their relationship with the land and water. All groups in the area stress the placement of their peoples in this landscape by the Creator. Thus, the Indian ancestry in the Basin extends from "time immemorial," a long-term attachment that is reflected in modern Indian culture.

The Indian peoples of the northern intermontane regions are part of a large, loose social web strengthened by their shared experience of the Columbia River basin and associated ecosystems. The traditional subsistence economy is broad-based. It includes fishing, fowling, hunting, trapping, livestock grazing, and gathering of terrestrial and aquatic resources, over very large geographic areas encompassing a diverse range of important places. The full range of resources needed to sustain families and Indian cultures was found in their socially and culturally important traditional-use areas. Living cultural traditions are embedded in these older understandings of the land, resources, landforms, habitats, and landscapes. Consequently, Indian peoples have accrued a "detailed, encyclopedic knowledge of their environment" through the millennia.

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The lower Klickitat River gorge near its confluence with the Columbia is one of the sites still used by American Indians for dip net fishing from traditional wooden platforms.

The intimacy with and length of attachment to the land and the totality of landscape importance has contributed to a strong sense of place for Indian peoples. Places of significance are created by an intersection of nature, cultural uses, social systems and cultural meanings. Knowledge of places is passed to each succeeding generation through oral traditions, performance of rituals, and personal experiences.

Resource acquisition activities such as fishing, hunting, and plant and mineral gathering are usually done within the context of traditional sociocultural and economic systems. For many Basin tribes, a series of spring and summer root, salmon, and berry feasts mark high points in Indian religious calendars. In addition to these substantial feasts, numerous other occasions occur throughout the year (often held in community longhouses, shorthouses, Indian Shaker churches, or private homes) and are supplied with traditional foods. These native foods are collected usually from a tribe's or traditional community's homeland and its socially and/or traditionally significant ecological places—typically places on reservation or public lands.

The importance of native plants has received relatively little recognition compared to other native resources, although use of plant resources as food in historical times was at least equal to, if not greater, than fisheries. In fact, food-plant resource locations, not fishery habitats, have been considered the critical variable for determining the placement of historic settlements in the Nez Perce region. Plants continue to be valued and their

parts used for purification, ceremonial, subsistence, commercial, and medicinal purposes and for creating objects of personal use, trade, gift-giving or sale.

Some of the plants identified by the ICBEMP as of tribal interest are characterized as habitat generalists and associated with terrestrial community types found widely distributed in the Basin. However, plants are considered significant in a given culture on the basis of how people recognize a plant and assign it values and/or uses. A plant like camas may be known to live in several habitat types, but only found in few places in the quality and quantity appropriate for harvest practices. A plant may occur in abundance in one tribe's area of interest and though known as a highly valued plant by another tribe, both cultures may not value it in the same way or to the same degree.

The aquatic/terrestrial world has cultural significance to tribes beyond its value as a source of food, medicine, textiles and other material resources. Its cultural significance is much more complex, involving social values and meanings that intertwine traditional societal, political, religious, and economic areas of modern native cultures.

Camas is an important plant for many American Indian groups.

Legal Context

The relationship of the United States government with American Indian tribes is based on legal agreements between sovereign nations, Federal recognition of their dependent sovereignty status, principles of jurisprudence, international law, and prevailing views of society and government policies toward American Indians. The body of this formal relationship involves the whole span our country's history and its ties with European culture and conventions in law.

A series of Indian trade and intercourse acts, initiated in 1790 and permanently adopted in 1834, became the cornerstone of Federal Indian policy. The Marshall Trilogy (three Supreme Court decisions made between 1823 and 1831) is another significant early contribution to Indian law. It established: (1) only the Federal Government has the pre-emptive right to procure Indian land; (2) the Federal Government has trust responsibilities toward American Indian tribes; and (3) treaties take precedence over state laws.

In 1855, some Indian nations within the Basin entered into treaties with Isaac Stevens, Governor and Superintendent of Indian Affairs for the Territory of Washington. These ratified treaties provided for apportionment of land and natural resources and still serve that purpose today. Tribes affected by these treaties include the Confederated Tribes of both the Colville and Umatilla reservations; Confederated Tribes and Bands of the Yakama Nation; Nez Perce Tribe; Kootenai Tribe of Idaho; and the Salish and Kootenai Tribes of the Flathead reservation. The Blackfeet Tribe, located adjacent to the Basin and potentially affected by the project, also made treaties with Governor Stevens in 1855. These treaties

After the Modoc Indian War this traveling group was organized to awaken the nation to the plight of the Indian, circa 1875.

contain similar language that reserves for tribes certain pre-existing rights. One such example is from the treaty with the Nez Perce:

The exclusive right of taking fish in all the streams running through or bordering said reservation is further secured to said Indians; as also the right of taking fish at all usual and accustomed places, in common with citizens of the Territory, and of erecting temporary buildings for curing; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.

Significant to public land management is that treaty reserved rights and retained aboriginal use rights directly involve BLM- and FS-administered lands. Tribes and traditional Indian communities have areas of interest that are based on prehistoric and historic land use patterns. These not only extend beyond reservation boundaries, but often beyond lands that tribes ceded to the United States because ceded lands were typically delineated by non-Indians and were not accurate representations of tribal homeland areas, and customary land uses routinely extended beyond Indian homelands.

The rights retained by tribes are viewed by them as an assurance by the U.S. Government to

Through legal agreements, tribes received promises of Federal protection for their lands, resources, and people.

allow for the continuation of traditional land uses. Thus what is reserved are the supports of a way of life for Indian communities, not just resource uses. Through legal agreements, tribes received promises of Federal protection for their lands, resources, and people. These are viewed as promises that constitute Federal Government fiduciary responsibilities, also called trust responsibilities/obligations. The benefits that were gained by the United States, establishing legal rights to Indian lands and providing U.S. citizens with a basis for economic, political, and social development in the Northwest, were considerable.

In 1974, the U.S. Washington District Court reaffirmed off-reservation fishing rights and their priority over other uses. Upheld by the Supreme Court in 1979, tribes were allowed up to a 50 percent share of harvestable fish passing by accustomed traditional fishing places. It also recognized the sovereign right of tribes to regulate their off-reservation treaty rights; states regulate tribal use for conservation purposes only. An important aspect of this decision is the surmised right of tribes to take part in the protection of fish habitats, helping to ensure that the resource persists and in quantities available for fishing.

A number of Federal regulatory acts passed in recent decades have increased the roles of tribes in public land management decision-making processes. That portion of case law pertaining to off-reservation tribal interests and Federal agency land management is reflected in recent Federal administrative policy and guidance.

Implications for Ecosystem Management

Tribal governments have an increasing influence on the formulation of public land policy through agency recognition of their legally established rights as well as their unique trust relationship with the United States Government. In recent years, there has been an increased understanding about the sovereign status of tribes and government-to-government relations between tribes and agencies have been established. Because of this status, American Indians do not view themselves as another "special interest" that needs to be factored in (or traded off) with other interests when Federal agencies develop a land management plan. This has developed into increased tribal participation in all agency planning levels. Increased opportunities to contribute to implementation and monitoring stages of projects are also seen as important.

Recognition of the uniqueness of each tribe has placed the burden on agencies to become knowledgeable and sensitive to Indian interests on an individual tribal basis. Variation among tribes is notable in their demographic characteristics, the nature of their reserved rights, and their interest in and dependence on public land resources. An ongoing dialogue would benefit agency-tribal relations if established "locally" over and beyond the notification and consultation requirements associated with regulatory acts.

With passage of the Self-Governance Act late in 1994, increased emphasis is being placed on involving tribes in the Federal management processes, including development and implementation of land use plans, preparation of budget

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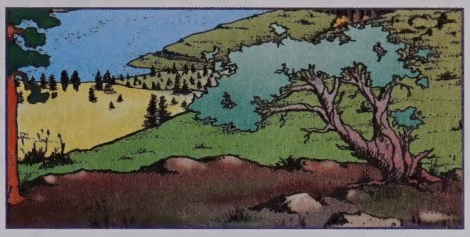
Meaningful dialogue through an effective consultation process is an important issue among tribes. Consultation is not a single event, but a process that leads to a decision.

proposals, and carrying out other activities on public lands on behalf of the agencies. Tribes also now have the option to consider incorporating programs or functions (otherwise under Federal agencies) into their tribal responsibilities if they are interested and can provide justification. Indian tribes are a valuable source of expertise on local resources, having built staffs with academic credentials blended with knowledge passed down through generations. This expertise can be applied to public land planning, implementation, and monitoring.

Meaningful dialogue through an effective consultation process is an important issue among tribes. Consultation is not a single event, but a process that leads to a decision. Consultation serves at least four purposes: (1) to identify and clarify the issues; (2) to provide for an exchange of existing information and identify where information is needed; (3) to identify and serve as a process for conflict resolution; and (4) to provide an opportunity to discuss and explain the decision.

Consultation means different things to different tribes. It can be a formal process of negotiation, cooperation, and policy-level decision-making between tribal governments and the Federal Government, or a more informal process. Consultation can be viewed as an ongoing relationship between an agency (or agencies) and a tribe(s) characterized by consensus-seeking approaches to reach mutual understanding and resolve issues. Developing a consistent approach to consultation that meets tribal needs is one of the challenges of ecosystem management.

BIOPHYSICAL SETTING AND LANDSCAPE DYNAMICS



The Basin's biophysical environment is composed of its geologic, geoclimatic, climatic, potential vegetation, soil, and hydrologic systems. These are important to ecological assessment of the Basin because they help describe terrestrial and aquatic ecosystems that behave in a similar manner, have similar potentials for production, and exhibit similar hazards and management limitations. Areas with common characteristics respond to disturbance processes and management activities in a similar manner.

Biophysical characteristics such as climate, potential vegetation, and geology do not change readily over time. Therefore, they provide a useful basis for comparing elements that do change over time (for example, vegetation) in response to disturbance or management activities.

Elevation and topography within the Basin vary considerably, from just above sea level to over 13,000 feet, and from flat plains to steep mountain ranges (see map 1). Much of the present landscape of the Basin was shaped by processes and events during the Pleistocene epoch (1.6 million years to 10,000 years ago). This was a time of multiple cycles of major climate variation, ranging from ice ages to warm interglacial periods. The climax of the last cold period was 20,000-14,000 years ago, when average summer temperatures in the Pacific Northwest were 9 to 12 ^{0}F cooler and winter temperatures were about 18 to 27 ^{0}F lower than today. During these cooler and moister times, large ice sheets formed in the Northern Hemisphere that covered most of Canada and the northern United States.

Alpine glaciers shaped valleys along much of the northern part of the Basin. Many of these glaciated landscapes are now covered with a mantle of glacial till. Downstream from glaciers (and in the wake of retreating glaciers), thick sedimentary layers of silt, sand, and gravel outwash were left as valley fill and terraces that now contain the glaciated headwaters of many rivers. Valley bottoms inundated by glacier-dammed lakes currently have thick mantles of silt and sand lake deposits.

Potential Vegetation

This is the vegetation that would likely develop on a given site if all successional sequences were completed without human interference under present site conditions. Potential vegetation types (PVTs) are the species that might grow on a given site in the absence of disturbance. Potential vegetation groups (PVGs) are made up of potential vegetation types, grouped on the basis of similar moisture or temperature environment, such as warm/dry or cold/wet forests, or cool/dry and warm/moist shrublands. For example, lodgepole pine is associated with dry forests, mountain hemlock with cold forests, fescue with dry grasslands, and mountain big sage with cool shrublands.

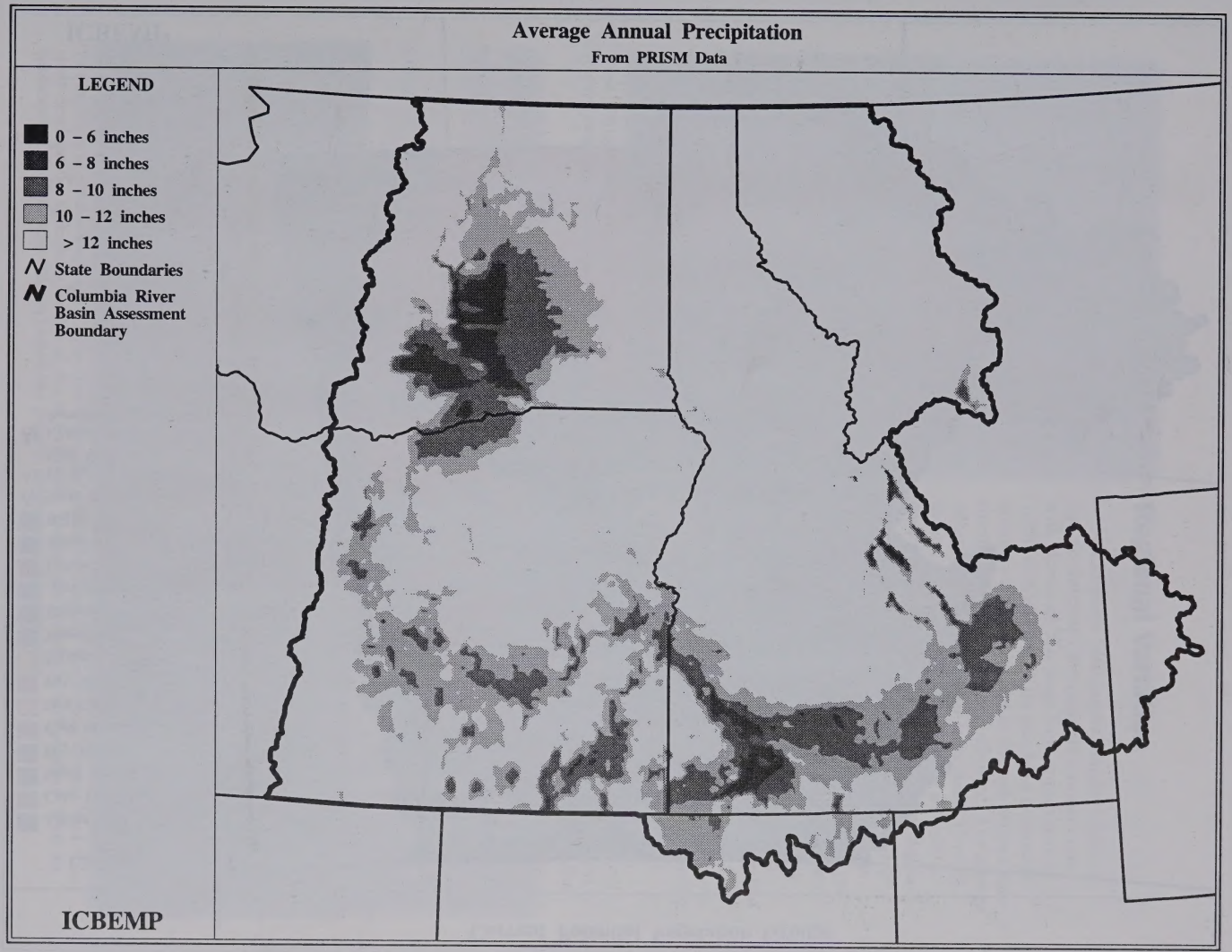
Portions of the Basin that receive less than 12 inches of precipitation annually are more susceptible to the effects of drought or human land use activities; vegetation takes longer to recover.

During the Pleistocene ice ages, silt and fine sand outwash from alpine and continental glaciers and glacial floods were redeposited by wind as thick blankets of loess. These loess deposits, which locally dominate many landscapes of the Basin, form highly productive soils. The rolling hills of the Palouse in eastern Washington are composed entirely of loess, which has been deposited over the last two million years and is locally over 250 feet deep. Similar deposits of loess cover much of the Columbia Plateau and Snake River plain.

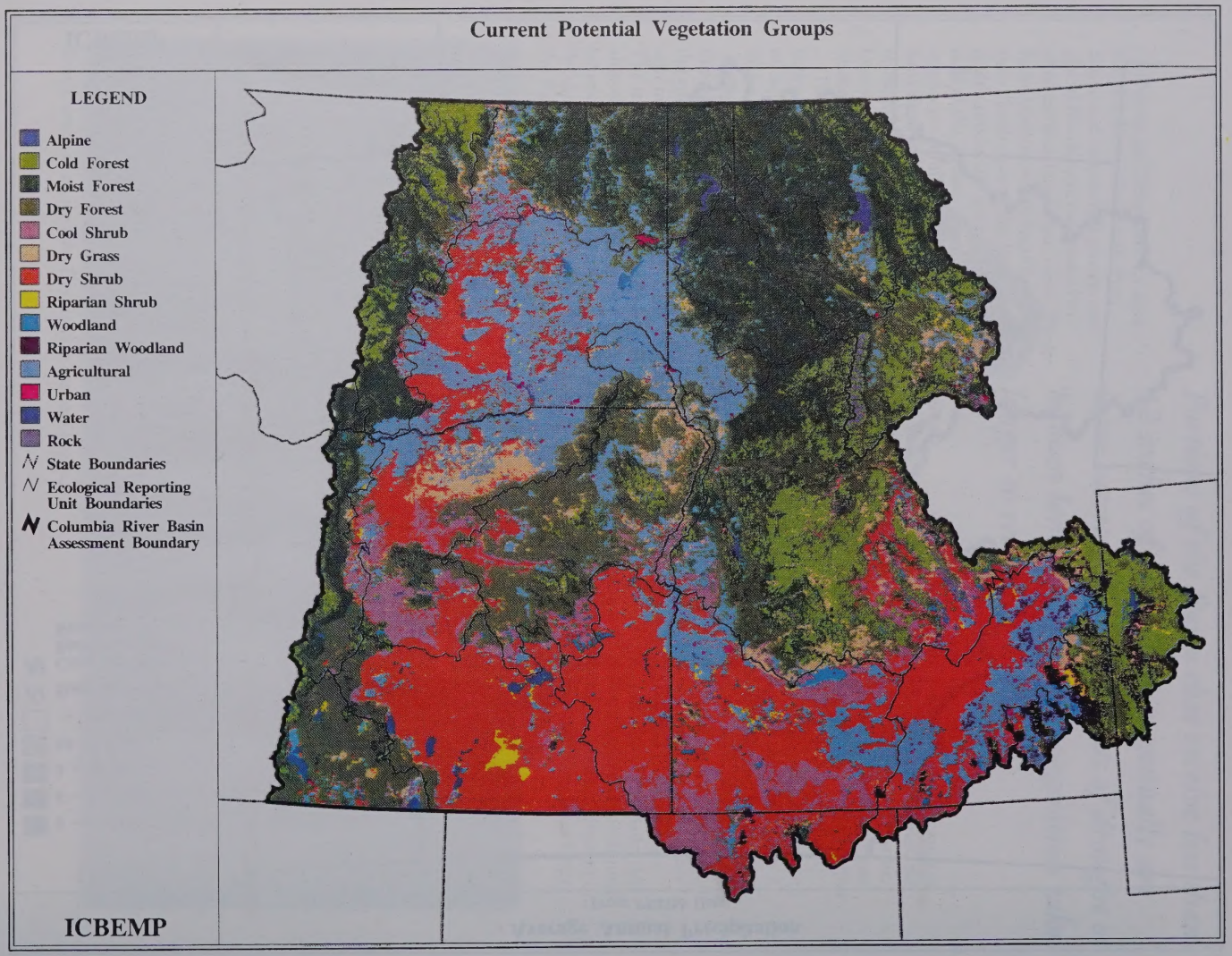
The wetter climate of the last ice age led to the formation and expansion of large freshwater lakes in closed basins throughout the western United States. The presence of these lakes resulted in deposition of silt and clay on inundated valley floors. These lake systems rapidly evaporated at the end of the Pleistocene, and by 10,000 years ago, most lakes approximated their present size. The reduction in size of these lakes substantially altered the patterns of hydrologic connectivity between now-separated basins, strongly affecting the distribution of many aquatic species within the Basin.

The Basin's climate influences Basin resources and their uses. Proceeding from west to east, the climatic gradients generally have more moisture. Proceeding from north to south, the climate generally becomes dryer, and glaciation had less effect on landforms and soils. Weather observations and the general retreating of glaciers since the late 1800s indicate a general warming trend. **Map 7** displays average annual precipitation for the Basin. Along with other characteristics, climate determines the type of vegetation that can grow in a given area, as well as how vegetation and other ecosystem components respond to disturbance (**map 8**). For example, portions of the Basin that receive less than 12 inches of precipitation annually are more susceptible to the effects of drought or human land use activities; vegetation takes longer to recover.

Woody debris along the John Day River in central Oregon.



Map 7—Precipitation.



Map 8—Current potential vegetation groups.

View of Mount Rainier from the Cascade Crest, the western most extent of the Basin.

Regional Variation

Northeastern Washington, northern Idaho, and northwestern Montana are mountainous, with elevations that range from approximately 1,200 to 9,500 feet. This area has a maritime-dominated climate except in the east where a continental climate has greater influence. The average annual precipitation varies from about 15 to 25 inches, most falling in winter. The warm/dry, cool/moist, and cool/dry forest potential vegetation groups (PVGs) are currently dominated by cedar/hemlock, ponderosa pine, western white pine, and Douglas-fir forest cover types. Soil productivity is generally good because of the volcanic ash soils and the presence of favorable temperatures and precipitation (maritime climate and low-to-moderate elevations). The dominant valley bottom settings include both steep, confined valleys with step-pool and rapids-dominated streams, and broad, gently sloping valleys with meandering streams in well developed floodplains at lower elevations.

Central Idaho, west-central and southwestern Montana, and northeastern Oregon range from approximately 1,000 to 12,000 feet; most of the

Palouse River of eastern Washington. The river breaks and scablands of eastern Washington have not been extensively developed for agriculture because of thin or rocky soils. This picture provides us with an idea of what the landscapes of the Columbia Plateau looked like prior to development for agriculture.

Rangelands of southeastern Washington and eastern Oregon. Because of thin soils much of this rangeland has not been developed for agriculture and in eastern Oregon much of the range is in public ownership.

Remnant native grassland in eastern Washington. Most of the very diverse, productive native grasslands with deep soils have been developed for agriculture.

Walla Walla and the Blue Mountains. Transition from the plains of the Columbia Plateau to the Rocky Mountains.

Rocky Mountains of western Montana and Wyoming.

higher elevations have been glaciated. The landscape includes mountains with narrow valleys, basins, alpine meadows, and breaklands. Maritime climate, westerly winds, and mountainous terrain yield less than 20 inches of precipitation at the lowest elevations to over 30 inches in mountainous areas. The warm/dry, cool/moist, cold/wet, cold/moist, and cool/dry PVGs are currently dominated by Douglas-fir, ponderosa pine, and grand fir forest cover types and by sagebrush and fescue/wheatgrass grassland cover types. Soils are only moderately productive because of shallow depths associated with cold temperatures and low precipitation in many areas. The most productive soils occur in valleys and basins where they are often deep and have high volcanic ash content. Heavy fuel accumulations and dense stand conditions in some areas place long- and short-term soil productivity potential at risk from wildfire. The dominant valley bottom settings include both steep, confined valleys with step-pool and rapids-dominated streams, and broad, gently sloping valleys with meandering streams in well developed floodplains at lower elevations.

The plains, tablelands, and plateaus in central Washington, southcentral and southeastern Oregon, and southern Idaho range from approximately 200 to 8,000 feet. This area has a semi-arid, cool climate, with average annual precipitation varying from about 5 to 25 inches. The warm/dry, cool/dry, and cool/moist shrubland and warm/dry herbland PVGs are currently dominated by sagebrush steppe and grassland cover types. Low productivity soils are common because of the sparse precipitation and low soil organic matter throughout much of the area. The dominant valley bottom settings consist mainly of steep, confined valleys with step-pool and rapids-dominated streams, and broad, gently sloping valleys with meandering streams in well developed floodplains at lower elevations. Entrenched, gully-like streams and braided streams also occur.

The eastern slopes of the Cascades in Oregon and Washington, along with the upper Klamath portion of the Modoc Plateau in southern Oregon, average about 10 to 40 inches of precipitation annually, falling primarily during winter. Elevations range from approximately 300 to 9,500 feet. The warm/dry, cool/moist, cold/moist, hot/moist, cool/very dry, and cool/dry forest PVGs are currently dominated by a mixed coniferous forest cover type consisting mainly of Douglas-fir and ponderosa pine. These forests have moderate to high productivity, but large portions of this area accumulate substantial amounts of fuels and have high probabilities of stand replacement wildfires. Stands in this condition are at high risk to losses of organic matter, coarse woody debris, and nitrogen. The dominant valley bottom settings consist mainly of steep, confined valleys with step-pool and rapids-dominated streams, and broad, gently sloping valleys with narrow, sinuous meandering streams in well developed floodplains at lower elevations. Wetlands and lakes also are common features.

Southeastern Idaho and western Wyoming have been shaped by overthrust faulting and glaciation, creating steep, rugged mountains with narrow to broad valleys having general north-south orientation. Most of this area occurs within 6,500 to 9,000 feet elevation with some of the highest peaks exceeding 13,000 feet. The climate is a semi-arid steppe with most of the 15 to 40 inches of annual precipitation occurring in the fall and winter as snow. The warm/dry, cool/dry, hot/very dry, and cool/dry forest PVGs and the warm/dry, cool/dry, and warm/moist shrubland PVGs are occupied by mixed, coniferous forest and sagebrush/grassland steppe. Douglas-fir, lodgepole pine, and aspen often occupy the northern aspects, while grasses and shrubs are found on southern aspects. Soils are generally moderately productive. The greatest productivity limitations are cool temperatures and short growing seasons due to the high elevations. Although less extensive, similar conditions of fuel accumulation and dense stand conditions occur as in the eastern Cascades. The dominant valley bottom settings include both steep, confined valleys with step-pool and rapids-dominated streams, and broad, gently sloping valleys with meandering streams in well developed floodplains at lower elevations. Braided streams also occur, but are far less common.

Landscape Dynamics

The landscape components of ecosystems are by no means static; sometimes changes occur quickly, such as from floods, fires, windstorms, or volcanic eruptions. Other times, the changes are slower and more subtle. Certain types of landscapes are prone to natural disturbances.

Biophysical environments and associated disturbance dynamics are very complex because of the diversity of topography and geology as well as the change in climatic gradients across the Basin. A disturbance is an event that changes the trend of ecosystem development; a disturbance such as a flood plays many roles in ecosystem functioning, including flushing debris and accumulated fine sediment, or delivering material for soil development to the floodplain. When disturbance events are detrimental to humans, we attempt to control them or minimize their effects—often disrupting the normal functions of the disturbance.

Historical Range of Variability

Historical range of variability (HRV) is a term used by ecologists to describe the natural fluctuation of ecosystems over time. In this project, HRV refers to the range of conditions and processes likely to have occurred prior to settlement of the Basin by Euro-Americans (about the mid-1800s). HRV serves as a reference point from which change can be measured, rather than a condition that ecosystem management tries to attain. In fact, science findings suggest that such a condition could not be achieved. This misunderstanding about HRV is common, as is the tendency to equate HRV with "natural" conditions. As discussed above, American Indians altered the landscape in many ways, though nowhere near the scale of change as populations increased, land uses evolved, and technology for altering the environment was developed.

Many human activities, such as construction of roads, dams and related facilities, introduction of exotic flora and fauna, conversion of land to agriculture or other uses, and exclusion of fire, can change the disturbance regimes and successional pathways of ecosystems. In many cases, human activities interact with natural disturbances to produce an entirely new effect.

Humans have had profound effects on Basin landscapes.

Humans have had profound effects on Basin landscapes. When humans change biophysical conditions by altering the topography, soil or parent material, introducing exotic species, or accelerating species or genetic extinctions, biophysical systems are subsequently changed, thus promoting changes in disturbance and succession regimes. Timber harvesting and livestock grazing, the introduction of exotic species and white pine blister rust, and the exclusion of fire have resulted in substantial changes in succession/disturbance regimes and associated vegetation composition, structure, and pattern. These regime changes are typified by more frequent disturbance with higher cumulative effects over time than those associated with historic regimes. There has been substantial simplification of the Basin's landscape composition, structure, and pattern; ecosystem responses to disturbances are now less predictable.

Landscape Patterns—Examination of current landscape patterns reveals that only 3 percent of Basin lands still have a pattern similar to historical patterns. Approximately 16 percent of the Basin has a reserve-type pattern. These areas include lands where passive management (such as that which takes place in designated Wilderness) has dominated and where few fires were allowed to burn except in the largest wild areas. These areas now experience disturbances that are less frequent but more severe, and have greater cumulative effects

A pattern of vegetation that is associated with traditional timber management. These disturbances, and the traditional placement of the road system, result in relatively severe effects on small patches each year that over many years accumulate into effects that are often negative to the soils, aquatic systems, and native species of wildlife and plants. Ecosystem management would attempt to mimic more natural patterns and effects.

than under the historical pattern. Sixty-four percent of the Basin has a commodity-induced pattern. In forested landscapes, this includes areas of timber management emphasis and fire exclusion, resulting in more frequent disturbance and greater effects than those of historical patterns. Seventeen percent of the Basin has other types of patterns (water, rock, urban, agriculture and other land uses). On BLM and FS lands, 5 percent of the area is in a pattern similar to the historical pattern, 29 percent is in a pattern similar to reserves, and 66 percent is in a pattern similar to commodity management.

On forested lands, managers of BLM/FS-administered lands commonly tried to accelerate the regeneration process of areas harvested or (to a lesser degree) burned by lethal fires. These regeneration policies shortened the regeneration period that was common to native systems, thereby reducing the extent of stand initiation structures. Precommercial thinning, another practice common to areas managed under traditional forestry strategies, was not extensive enough to mimic the maintenance and accelerated-cycling regimes of the native system. Consequently, successional sequences of many areas that were thinned stagnated until they were cycled by a disturbance event that was lethal to the overstory. Harvest patterns on lands administered by the U.S. Forest Service have been somewhat constrained since the National Forest Management Act of 1976. The restrictions limiting the size of harvest patches, and the trend towards smaller patches more recently, has led to the systematic fragmentation of forest landscapes.

There are different patterns of vegetation. This photo shows a natural pattern of vegetation that is associated with natural disturbance. The soils, aquatic systems, and native species of wildlife and plant have developed in concert with the type and intensity of disturbances associated with this type of pattern.

Traditional reserve or wilderness management has generally emphasized a passive approach to management, and thus involved little direct vegetation management, and a very conservative prescribed natural fire program. The guidelines for prescribed natural fires typically only allowed fires to burn that are lightning-ignited and that have a high likelihood of remaining within the reserve. Few lightning-caused fires meet the prescription guidelines. Consequently, the extent of current fire disturbances were well below those of the historical period. Therefore, traditional reserve management has also caused substantial changes in succession/disturbance regimes and the associated vegetation structures and composition. As with traditional timber management, measurable fire disturbances in reserves were less frequent, but more severe than they were in the native system.

On many rangelands, introduction of exotic plants, exclusion of fire, and traditional livestock management has also resulted in more frequent disturbances that have greater effects, substantially changing the succession/disturbance regime associated with historical patterns. These changes can affect long-term productivity and increase the likelihood of disturbances perceived as catastrophic.

On rangelands, the effects of traditional grazing or reserve management also had predictable patterns of changed succession and disturbance regimes associated with non-forest areas (**figure 6**). Traditional livestock grazing practices, fire

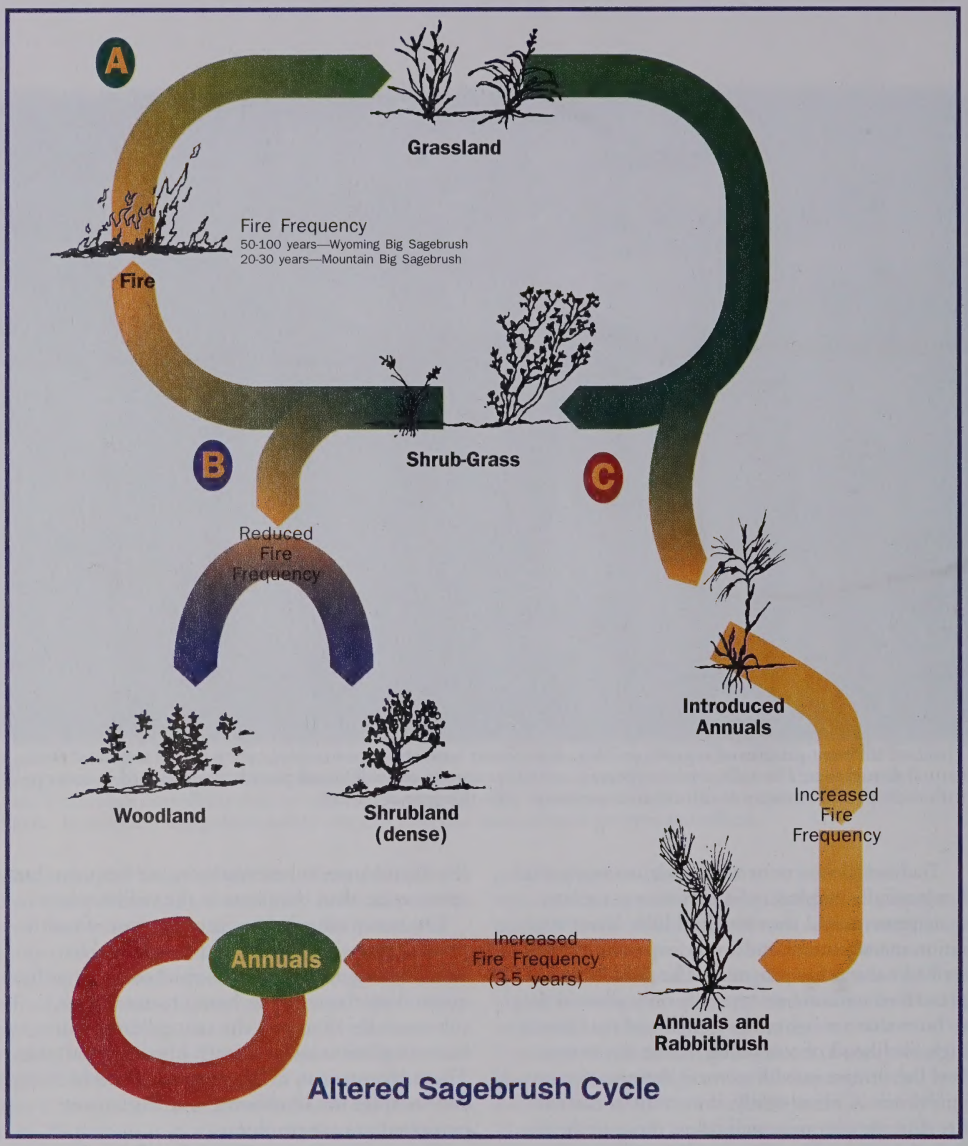


Figure 6—**Sagebrush Grassland Succession:** Three common pathways of succession in the sagebrush grassland. **Pathway A** represents a succession from a grassland to a shrub-grass dominated plant community, with fire acting to move the shrub-grass community back to a grassland. **Pathway B** represents succession of a shrub-grass dominated plant community to either a woodland (dominated mostly by juniper) or a shrubland, caused by a reduction in fire occurrence. **Pathway C** represents succession of shrub-grass dominated plant community to a community dominated by introduced annual grasses, characterized by an increase in fire occurrence. Introduced annual grasses have invaded these communities partially as a result of excessive livestock grazing pressure. Once dominated by introduced annual grasses, the community tends to remain this way because of frequent fire, which prevents shrubs from establishing. (Adapted from Vavra and others. 1994. *Ecological Implications of Livestock Herbivory in the West.*)

This photo shows a pattern of vegetation that is associated with fire suppression and exclusion of disturbance. When fires occur they are usually very intense because of accumulations of continuous heavy fuel. The soils, aquatic systems, and native species of wildlife and plants are often negatively affected by the intensity of these events.

exclusion, and the introduction of exotic weeds substantially altered the patterns and areal extent of lands affected by the succession and disturbance regimes. The succession and disturbance regime of the ridge landform, for example, changed from a maintenance regime to a long-cycling regime due to fire exclusion. As a result, the herb-dominated communities that commonly occurred historically have been replaced by communities dominated by conifers or junipers. In areas that do not have the potential to support trees, the herb-dominated communities are now dominated by dense, decadent shrubs. In either case, ignition probabilities declined substantially due to the lack of fine grass fuels. When these newer communities burn it is typically only during very dry conditions, rather than during the fire intervals common for the native system. Furthermore, the fires generally burn more severely than they did historically due to the increased amount of woody fuels that is now common to the ridge landforms. The more severe fires commonly kill the sparse understory of perennial grasses and forbs.

Landscapes that are dominated by a mosaic of both forest and rangeland PVGs have inherently more diverse succession and disturbance regimes, and vegetation patterns than the forest or rangeland dominated landscapes. Although the individual landform, PVG, and succession/disturbance regime relationships were generally the same as in the forest or rangeland dominated landscapes, the effects at the landscape level were substantially

Stand Initiation (SI)
Forest growing space is reoccupied by young trees following a stand-replacing disturbance (e.g., fire).
Stem Exclusion, Open Canopy (SEOC)
Occurrence of new trees is excluded (moisture-limited situation); the forest canopy is broken and tree crowns are open-growing.
Stem Exclusion, Closed Canopy (SECC)
Occurrence of new trees is excluded (light-limited situation); the forest canopy is closed and tree crowns are abrading.
Understory Reinitiation (UR)
A new age group of trees establishes under the mortality-induced openings of the older overstory.
Young Forest, MultiStory (YFMS)
Several age groups are established; large trees are generally absent.
Old Forest, Single Story (OFSS)
Understory trees generally are absent; large trees are present and significant in the overstory.
Old Forest, MultiStory (OFMS)
Diverse horizontal and vertical distributions of tree sizes occur; with large trees also present and significant in the overstory.

Figure 7—Structural Stage Definitions.

different. The forest-rangeland landscape mosaic has many complex ecotonal and contagion relationships among the different kinds of environments and communities.

In general, the changes that occurred in forest-rangeland landscapes have been more substantial than the observed changes in either the forest or rangeland landscapes because the energy gradients are steeper, the disturbance regimes are more dynamic due to the forest-rangeland mosaic, and the diversity of species are higher.

Vegetation dynamics—This analysis described vegetation by structural stages (**figure 7**; **table 3**). Both the late-seral multi-layer and single-layer structural stages have declined substantially, and the late-seral multi-layer that now occurs is generally occupying a different place on the landscape. Historically, late-seral multi-layer forested types were in moist areas such as bottoms and benches and were maintained by succession and disturbance regimes. Timber harvesting and the exclusion of fire have resulted in late-seral multi-layer forest developing on the dryer slopes. The amount of small dead-standing and down material has increased. Considerable small-diameter timber volume remains, providing opportunities for harvest that could be accomplished in an ecologically beneficial manner with appropriate technology. Whether revenues from these harvests will exceed treatment costs is dependent on site-specific conditions, timber markets, and costs of treatment.

Figure 8 summarizes changes in landscape elements in the Basin. Across the Basin, the greatest change is from the expansion of agriculture, which

Figure 8—Current and historic landscape elements.

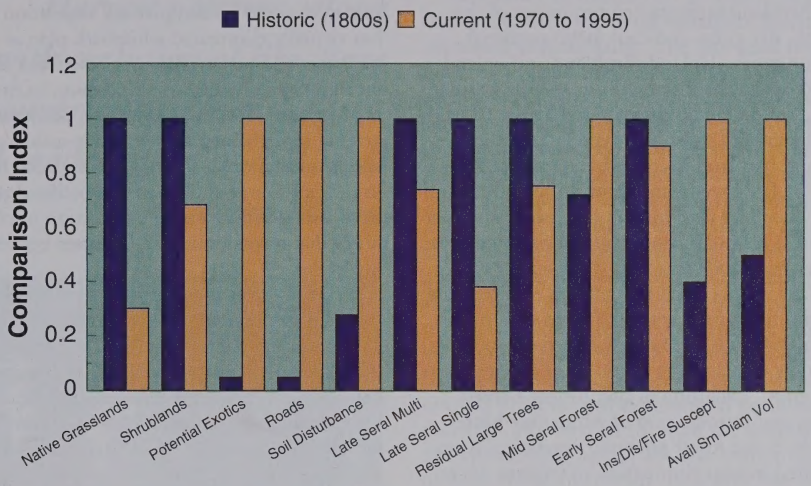


Table 3—Structural stages often used to describe changes in forest vegetation structure over time.

Structural Stage	Definition	Also Referred to As:
Stand initiation	When land is reoccupied by trees following a stand-replacing disturbance.	Early-successional Early-seral Regeneration
Stem exclusion-open canopy	Forested areas where the occurrence of new trees is predominantly limited by moisture.	Mid-successional Mid-seral Young forest
Stem exclusion-closed canopy	Forested areas where the occurrence of new trees is predominantly limited by light.	Mid-successional Mid-seral Young forest
Understory reinitiation	When a second generation of trees is established under an older, typically seral, overstory.	Mid-successional Mid-seral Young forest
Young forest multi-story	Stand development resulting from frequent harvest or lethal disturbance to the overstory.	Mid-successional Mid-seral Young forest
Old multi-story	Forested areas lacking frequent disturbance to understory vegetation.	Late-successional multi-story Late-seral multi-story Old forest multi-story
Old single-story	Forested areas resulting from frequent non-lethal prescribed or natural underburning, or other management	Late-successional single-story Late-seral single-story Old forest single-story

occurred primarily in the upland shrubland and upland herbland terrestrial communities of the dry shrub, dry grass, and cool shrub potential vegetation types. Upland shrubland and upland herbland declined substantially across the Basin as a whole, but on lands administered by the BLM or FS, the upland shrubland type increased while the upland herbland decreased, due to the exclusion of fire from woodlands and shrublands. The upland woodland type increased substantially over the Basin as a whole, also a result of fire exclusion.

Native grasslands also have declined substantially. This has occurred not only on non-forested rangelands but also in grassland areas within the forest. Shrublands have also declined substantially, generally displaced by exotic plant species such as cheatgrass. Exclusion of fire, timber harvest practices, and introduction of white pine blister rust in the moist forest potential vegetation types has resulted in near elimination of western white pine as a dominant species, increased intervals between fires, and increased severity of fires.

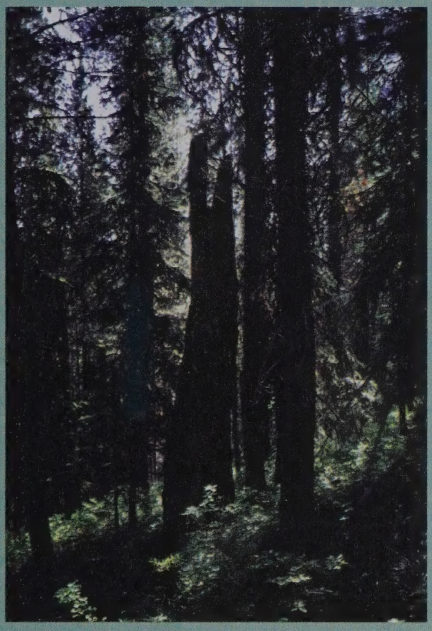
Exclusion of fire and introduction of blister rust in the cold forest potential vegetation types has virtually eliminated whitebark pine as a dominant species, increased intervals between fires, and increased severity of fires. Exclusion of fire, shifting of grazing from low-intensity, dormant-season grazing to high-intensity, growing-season grazing, and introduction of the exotic Kentucky Bluegrass in the cold forest and riparian woodland zones have resulted in substantial reduction of communities that were dominated by aspen between the fire cycles.

Reserve and wilderness management also have caused substantial changes in succession/disturbance regimes and the associated vegetation structures, although not to the extent of commodity management. In general, the disturbances are of lower frequency, are more acute, and have higher severity in cumulative effects than under historical regimes. Typically, both community structure and patch diversity decline under reserve and wilderness management.

Early-seral shrub, herb, and tree seedlings w/ dead standing trees from a crown fire one year ago. Natural succession occurs rapidly on most disturbed areas. Only one year after the fire, this area is now covered with shrub and herb regeneration and has many tree seedlings. Many of the native plants seen here can only grow in a post-fire environment because their seeds are stored in soil and only germinate with the heat effects of the fire.

Mid-seral stand of pole size trees with an understory of shrubs and herbs.Successional growth to dominance by trees occurs within 30-50 years. These mid-seral stands are typically fairly dense, but are naturally thinned by ground fires, insect and disease attacks, or stress. Generally, the trees that are less healthy die, allowing the healthier trees more moisture and nutrients, which accelerates their growth.

Harvest patterns, along with exclusion of fire, have converted much of the late-seral communities to mid-seral communities.



Late-seral stand of larger trees with snag and understory of shrubs and herbs. Successional growth to later-seral large trees with snags and a more open canopy occurs over the next 40-80 years. Natural disturbances thin and promote growth of the large trees and eventually may cycle the stand back to the early-seral stage. Rangelands and riparian systems have similar dyna-mics of disturbance, such as large ungulate grazing, fire, insects, disease, and floods, with similar stages of successional response from post-disturbance to dominance by herbs or shrubs.

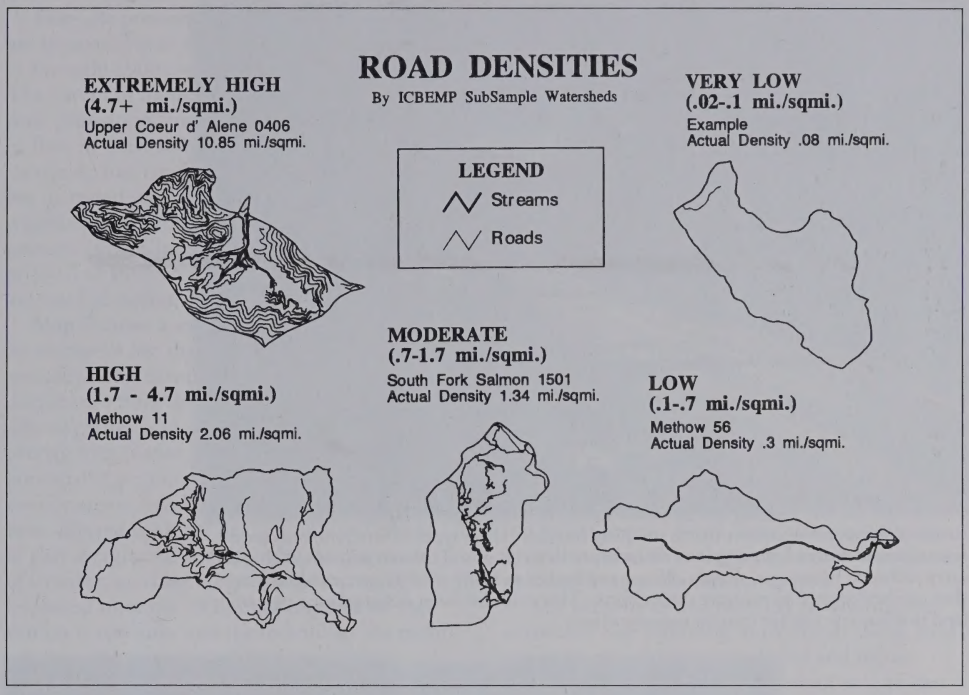
As a result of blister rust mortality of whitebark pine, the early-seral subalpine forest increased substantially. The late-seral montane forest converted to mid-seral forest as a consequence of timber harvest patterns, fire exclusion, and loss of western white pine to blister rust. A similar trend of increased mid-seral forest occurred in the lower montane forests.

Large trees that are shade intolerant and fire-, insect-, and disease-resistant species have generally been harvested from both the mid-seral and late-seral communities either selectively or as part of even-age treatments (clearcuts, seed tree cuts). Fire detection and control efforts have largely excluded fire from these areas. Late-seral communities developed over long periods of time, and experienced periodic fires that typically burned through the understory and maintained open park-like communities of large shade-intolerant trees with low susceptibility to mortality from stress, fire, insect, or disease. Harvest patterns, along with exclusion of fire, have converted much of the late-seral communities to mid-seral communities. Historically, the mid-seral communities either burned with crown fires and cycled back to early-seral communities or developed into late-seral communities. Not only is there a large increase in the mid-seral communities, but the current communities are more dense and have higher mortality, higher fuel loadings, and higher susceptibility to crown fire than historical communities.

There has been a decrease in diversity associated with exclusion of fire, intrusion from exotic biota, and/or heavy grazing during the growing season. This has caused a decline in communities that were historically dominated by western white pine, whitebark pine, ponderosa pine, western larch, aspen, cottonwood, riparian willows, bluebunch wheatgrass, bitterbrush, mountain mahogany, and the salt desert shrub complex.

Map 9—Predicted road density classes.

Figure 9—An example of road densities for subwatersheds within the Basin.



Roads—Roads cover enough of the Basin to be considered a component of the biophysical environment; in some wildland areas, road densities make up as much as 5 to 10 percent of the land base. Because a complete road inventory was not available for analysis, road density was predicted from models (**map 9**). The vast majority of FS and BLM roads are gravel or dirt and are passable only by high-clearance vehicles. Areas with no roads are found primarily in Wilderness, semiprimitive roadless areas, and national parks. Very low densities (**figure 9**) occur primarily in the rangelands of the valleys and plains, while low densities occur primarily in agricultural lands.

The vast majority of FS and BLM roads are gravel or dirt and are passable only by high-clearance vehicles.

High road density is found primarily in the intensively managed forestlands of both public and private ownership, and the highest density typically occurs in developed urban/rural areas.

High road densities and their locations within watersheds are typically correlated with areas of higher watershed sensitivity to erosion and sediment transport to streams. Road density also is correlated with the distribution and spread of exotic annual grasses, noxious weeds, and other exotic plants. Furthermore, high road densities are correlated with areas that have few large snags and few large trees that are resistant to both fire and infestation of insects and disease. Lastly, high road densities are correlated with areas that have relatively high risk of fire occurrence (from human caused fires), high hazard ground fuels, and high tree mortality.

Roads create an environment that is uniquely human. These types of environments are often associated with a high degree of disturbance in terms of soil erosion and runoff that can carry sediment to streams. Roads also act as a barrier to many wildlife species, although they can be designed to mitigate these effects. This road has been designed on a type of land that has low risk for causing negative effects.

In contrast, this road has high potential for negative effects.

Fire—At present, fire frequency and intensity are approaching or exceeding those experienced in the early 1900s, when many wildfires occurred. The advent of improved technology for fire detection, prevention, and suppression led to a decline in fires in the 1960s. However, with steadily increasing fuel conditions, the amount of wildfire has increased since then. The average cost of wildfire suppression, fatalities of firefighters, and amount of high-intensity fire during the period of 1970 to 1995 are double the corresponding amounts occurring from 1910 to 1970.

Map 7 shows areas of the Basin that receive an average of less than 12 inches of precipitation annually. These lands are highly susceptible to disturbance from drought, invasion of exotic annual grasses, and wildfire. Combining this overlay with roaded dry shrub and dry grass potential vegetation types in valley and plains environments reveals areas that have typically been affected the most by the combined effects of past overgrazing and drought. Management of livestock on these ranges has substantially improved since the 1930s, but response of vegetation is very slow and the technology for restoring these systems is generally not available.

The combination of potential vegetation types and road density makes many portions of the Basin susceptible to invasion by exotic weeds (**map 10**). The dry forest, cool shrub, dry shrub, dry grass, and riparian potential vegetation groups are all potentially susceptible to exotic weed invasion.

One of the key results of many of these alterations across the Basin has been the corresponding change in fire potential and behavior. In general, lethal fires have increased. In particular, the lethal, very-frequent fire regime class has increased substantially, while nonlethal, very frequent fires have declined from historic conditions. **Maps 11 and 12** show the portions of the basin most affected.

Complex changes have occurred in rangelands resulting in increases in the nonlethal infrequent and mixed infrequent classes. In these environments, livestock grazing reduced fine grass fuels that contributed to less frequent fires. However, improved fire detection and control techniques have resulted in the increase of woody fuels, causing higher severity when fires occur. Additionally, introduction of annual grasses has increased flammability in areas that are not grazed.

The occurrence and intensity of wildfires are correlated with lightning storm routes, fuels, local wind patterns, terrain complexity, and roads. Wildland areas with complex terrain or a moderate or high road density have moderate or higher risk of wildfires. Foothill and mountain terrain facing west or east typically have high potential for wind that can cause rapid spread of wildfires. Areas with fuels, roads, and complex terrain that are on lightning storm routes have the highest risk of wildfire. The areas in the moderate category often have a lower probability of wildfire in any one year, but have high fuel accumulations, such that the fires can be very large and intense.

Another change is that more people live in urban and rural settings adjacent or within an area of wildland vegetation that has high risk of fire (map 13). Those areas are of concern relative to providing for the safety of people and protection of homes as well as for the cost of fire suppression and safety of firefighters.

Fire Frequency and Severity

Fires can be described by their effects on vegetation and how often these effects occur. The severity classes are non-lethal (does not kill the dominant layer of plants), mixed (mixed effects), lethal (kills the dominant layer of plants), and rarely burns. An interval of 0 to 25 years is considered very frequent, 26 to 75 years frequent, 76 to 150 years infrequent, 151 to 300 years very infrequent, and greater than 300 years extremely infrequent.

Areas Susceptible to Potential Exotic Weed Invasion

Dominant Dry Forest, Dry Grass, Dry Shrub, and Cool Shrub PVGs

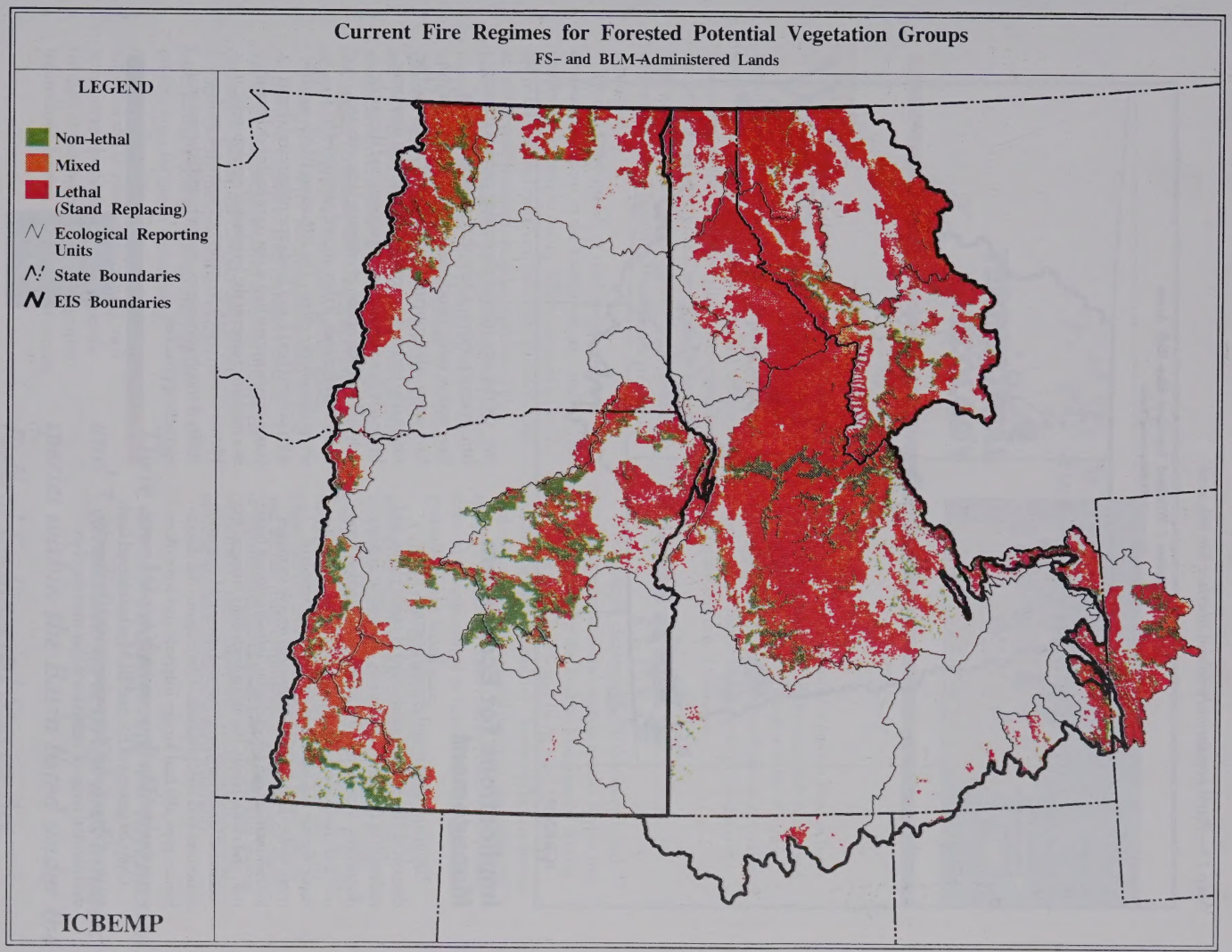
Map 10—Areas susceptible to exotic weed invasion.

Ground fire. Disturbances result in dynamic changes in vegetation, animal habitats, effects on aquatics, and effects on resource values. This is a ground fire disturbance which has very different effects from crown fires.

Post-crown fire dead standing trees and ash. Although a burned over stand of dead trees appears to be lifeless, it is still a very dynamic place. Birds such as the black-backed woodpecker actively seek out these areas for feeding. Nitrogen released from the burned foliage is available for seedlings and resprouting vegetation. Many plants are actively regenerating in this environment.

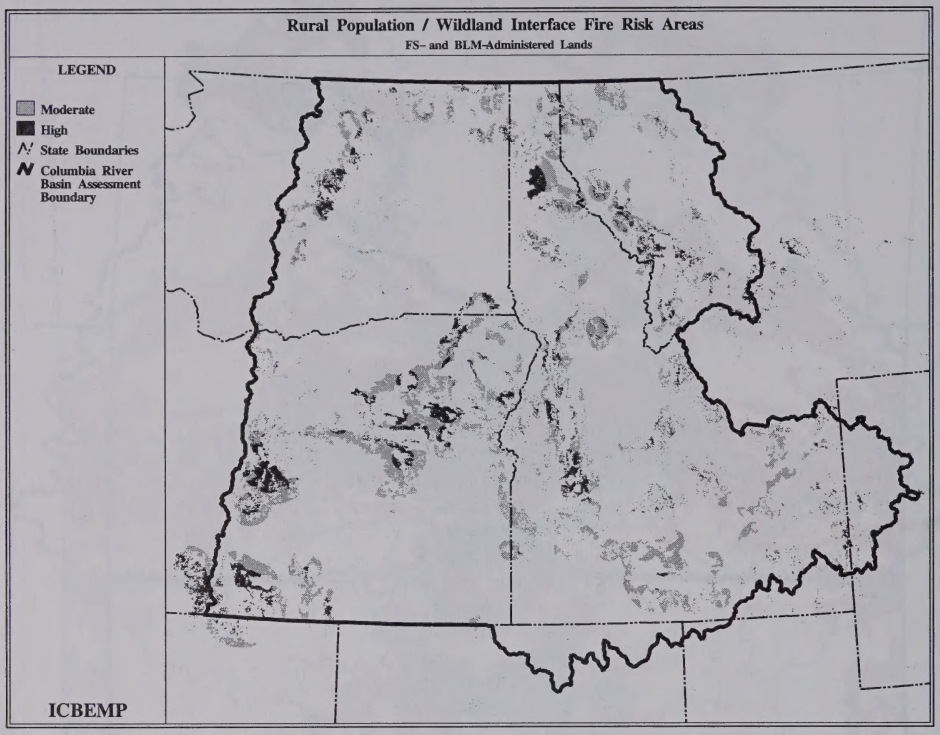
Crown fire. Crown fire burns through the tops of the trees, killing the overstory. Past efforts at fire exclusion have allowed fuels to accumulate in many areas that burn as crown fires, rather than as ground fires. Crown fires have much more severe effects on the soil, vegetation, terrestrial habitats, aquatic habitats, and resource values to humans, than ground fires.

Map 11—Historic fire regime for forested potential vegetation groups.



Map 12—Current fire regime for forested potential vegetation groups.

Map 13—Rural population/wildland interface fire risk areas.



Implications for Ecosystem Management

Traditional forestry and grazing practices, introduction of blister rust, introduction of exotic plants, and exclusion of fire, have substantially changed succession/disturbance regimes and the associated vegetation structure and composition. Typically, the change of disturbance regime was associated with longer intervals of more severe disturbances. Traditional reserve strategies, in conjunction with fire exclusion, introduction of blister rust, and exotic plants, has also substantially changed the succession/disturbance regimes and associated vegetation structures and composition. Once again, the disturbances typically had longer intervals and were more severe than the disturbance regimes of the native system.

Only 24 percent of FS- and BLM-administered lands are in conditions such that managers could manage for the historical range of variability if that were the objective. Of this area, most of the existing patterns are similar to reserve patterns. Often the capital, in terms of large trees or native bunchgrasses, is gone from areas that have commodity patterns; long periods of time would be required to restore the vegetative structures in these areas. In areas with reserve patterns, managers and the public may still have the option of retaining large trees and native bunchgrasses, if they are not preempted by a severe disturbance event. The remaining BLM- and FS-administered land is in a landscape pattern and disturbance regime system that is not completely predictable as a result of change in the biophysical environment. However, it is possible to improve this limited predictability through assessments, research, and adaptive management approaches.

TERRESTRIAL ECOLOGY

Widespread changes in biophysical conditions and disturbance patterns, coupled with increased human activity, have altered habitat available for diverse plant and animal species. The ICBEMP compiled the first catalog of biodiversity of the Basin, revealing diverse communities of fungi, lichens, plants, invertebrates (species without backbones, including insects and mollusks), and vertebrates. However, most species groups are unstudied.

Over 43,000 species of macroorganisms are estimated to occur in the assessment area and 17,186 species are known to occur. Micro-organisms, critical to ecosystem health and function, probably tally at least several hundred thousand species. This biodiversity results from the wide variety of habitats, topographic conditions, and prehistoric events within the study area. Over 14,000 species of macroorganisms were studied, and 1,339 individual species and 143 species groups were included in a database on species-environment relations (SER). Just under 300 species (excluding fish) were identified that are of particular interest to American Indian tribes.

Products from the terrestrial assessment of greatest potential interest to land managers include: (a) lists of habitats and associated species with greatest declines in area or distribution since historic times; (b) Species-Environment Relations databases listing species by habitats and ecological functions for use in determining potential effects of ecosystem management activities and in proactively crafting such activities to emphasize or restore specific habitats or functions; (c) 528 Geographic Information System (GIS) maps of species distribution and additional maps on areas of high biodiversity and species rarity and endemism; and (d) descriptions of key ecological roles of fungi, lichens, bryophytes, and invertebrates for maintaining ecosystem health and long-term productivity and sustainable use of resources.

Species at Risk

There are 19 endangered, 10 threatened, and 7 candidate terrestrial and aquatic species within the Basin listed under the Federal Endangered Species Act (**table 4**). The FS and BLM list 538 species (excluding fish) as sensitive. Some of the threatened and endangered species and many of the additional species of potential conservation concern are dependent on environmental or habitat components not evaluated at the broad scale.

A number of other taxa, especially plants and invertebrates, are worthy of additional attention: 394 fungi species, 40 functional groups of lichen species, sundry types of microbiotic crusts (not classified), at least 400 apparently regionally rare bryophyte species, 280 individual vascular plant species and 82 rare plant communities, 144 rare and endemic invertebrates (gastropods and insects), and various vertebrates. Basic inventories are needed for many of these species to determine their true rarity.

There are 19 endangered, 10 threatened, and 7 candidate terrestrial and aquatic species within the Basin listed under the Federal Endangered Species Act.

Table 4— Numbers of taxa (species, subspecies, fish stocks) by Federal listing status, and of special interest to American Indian tribes.

	U.S. Fish and Wildlife Service					Forest Service and Bureau of Land Management				
Class	Candidate	Threatened	Endangered	Federally Proposed Threatened	Federally Proposed Endangered	FS Sensitive	BLM Sensitive	Joint FS/BLM Sensitive	Total FS/BLM Sensitive	Tribal
Nonvascular Plants	0	0	0	0	0	3	10	1	12	4
Vascular Plants	2	1	3	0	1	371	113	45	439	205
Invertebrates	0	1	5	0	0	0	25	0	25	16
Fish	3	4	7	0	0	(...see *Component Assessment*, Aquatic Species and Habitats chapter...)				
Amphibians	1	0	0	0	0	2	5	2	5	0
Reptiles	0	0	0	0	0	1	5	0	6	2
Birds	0	3	2	0	0	22	23	12	34	34
Mammals	1	1	2	0	0	11	12	6	17	35
TOTAL	7	10	19	0	1	410	193	66	538	296

Listing status classes: Forest Service sensitive (in at least one state within the assessment area); Bureau of Land Management sensitive (in at least one state within the assessment area); Joint FS/BLM sensitive = same species listed by both FS and BLM as sensitive; TRIBAL = species identified by the ICBEMP Science Integration Team as of particular interest to American Indian tribes.

Species-Environment Relations

The SER database identified species closely associated with condition affected by management including forest canopy, mistletoe brooms, dead parts of live trees, trees with exfoliated bark, snags, down wood, litter and duff, fire, insect outbreaks, recreation, roads, and trails.

Native grasslands (*Fescue* bunchgrass, *Agropyron* bunchgrass), shrublands (big sagebrush), and old single-stratum and multi-strata stages of many forest types, especially lower montane ponderosa pine forests, have declined in total area and shifted in distribution since historic times. Declines are on both Federal and non-Federal lands, with most declines on non-Federal land. Many native species of fungi, lichen, plants, invertebrates, and vertebrates are associated with these types. Vertebrate species associated with the decline of old-growth forests include primary cavity excavators, predators and other species with large home ranges, and largely-unstudied species groups associated with forest canopies. Vegetation types (along with associated species) that have increased in total area and

The key ecological roles of lichens include contributing mass and nutrients to litter and duff, increasing canopy and soil moisture-holding capacity, fixing atmospheric nitrogen, serving as food for animals, and acting as bioindicators for air quality.

distribution since historical times include young successional stages of forests, conifer-encroached sagebrush, disturbed riparian conditions, and exotic plant communities.

Probably no terrestrial vertebrate has become regionally extinct in recent historic times, with the possible exception of the purple martin. Information on extinction of most non-vertebrate taxa is lacking. Some wide-ranging carnivores have greatly decreased in abundance and distribution and become locally extirpated (but not regionally extinct) in the Basin. Also, some small-bodied, less widely-vagile species may be at greater risk of declines or local extirpations. Edges of ranges are important for species conservation.

Fungi—The fungal flora and the effects of management activities on fungi are poorly known. Some species are important to recreational and commercial gatherers. Many kinds of fungi occur in the Basin, including species with narrow distributions, that fruit after fire, that fruit in dung, and that are mychorrhizal and saprophytic and thus depend on host plants. These fungi vitally contribute to plant and soil productivity. Fungi conservation can include protection of type localities in small, site-specific mycological (fungi species) preserves, inventory or survey of potentially rare species, and further study of biology and ecology of species.

Lichen serve many ecosystem functions and roles. Basic lichen surveys and studies of management effects are needed to supplement our currently poor knowledge base.

Native plant communities have declined significantly in the assessment area, prompting concerns about future conservation of rare species and rare plant communities.

Lichens—The key ecological roles of lichens include contributing mass and nutrients to litter and duff, increasing canopy and soil moisture-holding capacity, fixing atmospheric nitrogen, serving as food for animals, and acting as bioindicators for air quality. Some species are important to American Indians. The 736 lichen species were divided into 40 functional groups based on ecological relations. The groups occur on four main substrates: dead organic matter; corticate and decorticate wood; rock; and soil. Lichens are major components of native rangelands and provide critical soil functions, but have been threatened by exotic grasses, increased fire frequency, conversion of rangelands, and livestock trampling. Lichens are part of microbiotic crusts and are susceptible to damage from livestock grazing and trampling. One lichen, *Texosporium sancti-jacobi*, is listed as a Category 2 (C2) candidate species. Providing clumps of old trees and uneven-aged stands for their legacy of lichens can improve conservation of lichens.

The diversity of the Basin's native flora reflects the complexity of its biophysical environments.

Bryophytes—Most bryophytes have wide, Arctic-alpine and boreal distributions. Others are coastal and north Pacific or occur in arid environments as part of soil crusts; four taxa are endemic to the ICBEMP assessment area. Eleven ecological groups of bryophytes were identified based on common use of substrates. Changes in water quality affect aquatic submerged and wet-rock species. Forest canopy openings often adversely affect mycorrhizal species associated with decaying wood and forest humus and duff. Commercial collection of bryophytes may affect some of the humus and duff species. Other species in bogs, fens, and other environments are poorly studied. Dry soil species are critical to soil protection. Many species, at least 400, may be regionally rare but may need inventory to better determine their status, especially those occupying arid habitats, peatlands, floodplains, geothermal areas, isolated canyons, and on calcareous rocks and mineralized deposits. Bryophyte conservation can include training for identification, adding bryophyte identification to field vegetation plot data, and inventory of bryophytes in protected areas.

Vascular Plants—Vascular plants in the assessment area number at least 8,000 species, which include at least 154 local or regional endemics (found only in the area). This diversity results from complex biophysical environments along gradients of elevation, bedrock and soils, temperature, and moisture. Native plant communities have declined significantly in the assessment area, prompting concerns about future conservation of rare species and rare plant communities. Of particular concern are communities affected by grazing, introduction of exotic species, and timber

Providing a diversity of habitats, maintaining soil structure and soil chemistry, and preventing or eradicating exotic species could enhance conservation of invertebrate species.

harvesting. The sustained harvestability of some 205 plant taxa are of concern to American Indians. Conservation measures for all plants could include: monitoring of rare species and plant communities; off-site collection of pollen, seeds, and rare plants; and protection of key areas of high species rarity, endemism, and diversity.

Invertebrates—No terrestrial invertebrate species is listed as Threatened, Endangered, or Candidate (although five aquatic invertebrates are threatened or endangered). The FS does not list any as sensitive, whereas the BLM lists 25 as sensitive. Some 95 terrestrial mollusks would benefit from conservation attention singly or as groups; many of these are confined to calcareous substrates. Invertebrates are critical components of many ecosystem functions including detritivory (breakdown of matter) and nutrient cycling. There are 104 rare and endemic species that bear further watching. Functional roles of invertebrates include: detritivory and nutrient cycling; maintaining soil structure, chemistry, and productivity; wood decomposition; herbivory; pathogenic effects on other organisms as well as control of disease-causing organisms. Invertebrates can make excellent bioindicators of soil and vegetation health.

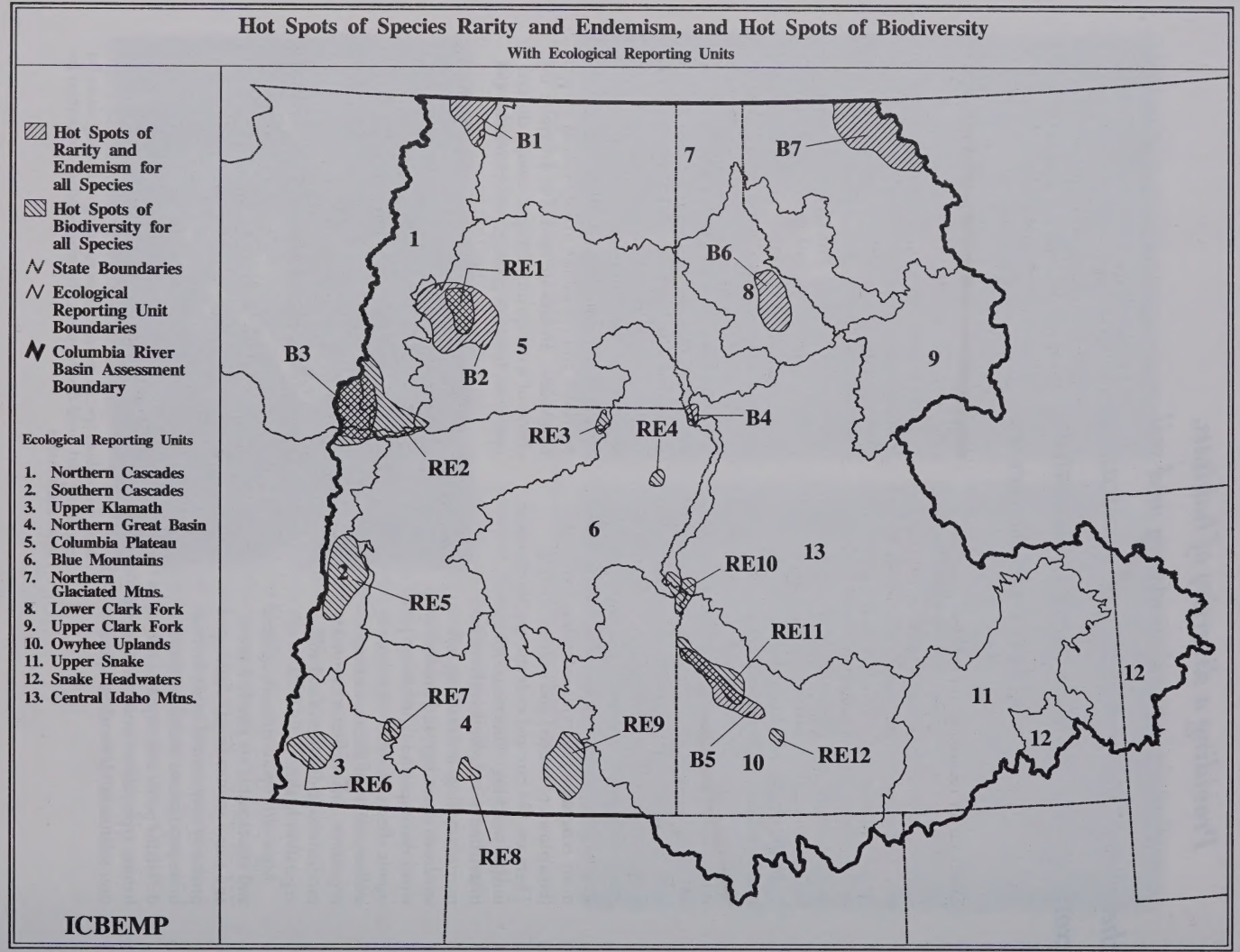
Most arthropods (insects, spiders, and crustaceans) are poorly known, and many are unnamed. Arthropod predators may control other invertebrate populations including some defoliator pests, and require a mix of habitat types, down wood, and vegetation substrates. Invertebrate pollinators, critical to maintaining the flora, are showing recent drastic declines. In grasslands and forests, species groups, particularly herbivores, are important links in food webs and affect vegetation succession. A few are agricultural or forestry pests. Fire and changes in soil chemistry directly affect invertebrates, especially in range and forest conditions altered from historic structures.

Other activities potentially harmful to desirable invertebrates include overgrazing, some recreation, loss of sphagnum bogs, exotic plants or arthropods, pesticide use, and other activities that compact or mix soils. Providing a diversity of habitats, maintaining soil structure and soil chemistry, and preventing or eradicating exotic species could enhance conservation of invertebrate species.

Vertebrates—Amphibians require water or moist environments, are susceptible to exotic species, and are associated more with substrates such as down wood or talus than with vegetation types or stages. Amphibians transfer nutrients from aquatic to terrestrial environments, are prey for predators, and contribute major biomass in forest ecosystems. Studies are needed to determine the effects of water quality changes, canopy closure, pesticides, livestock grazing, eutrophication, and

Most amphibian species require either standing or flowing water for egg laying and larval development. Riparian habitat is important for most adult forms.

Map 14—Hot spots for biodiversity and endemism.



ultraviolet radiation on amphibians and on their dispersal and distribution.

Distribution of reptiles is more closely associated with elevation, aspect, and substrate than with vegetation. Reptiles are susceptible to dams, off-road vehicle use, loss of wetlands, livestock grazing, and fire suppression. Better survey techniques for reptiles are needed.

Birds are susceptible to management-induced changes in vegetation, especially historic declines in old, single-stratum, interior ponderosa pine forests and grasslands dominated by *Agropyron* bunchgrass. In particular, changes in grasslands have caused declines in Columbian sharp-tailed grouse numbers. Neotropical migrants would benefit from conservation and restoration of riparian, old forest, shrub-steppe, grassland, and juniper habitats. Population or habitat declines of mammals include some bat species and predators. Few locations still contain all top predators.

Biogeography, Endemism, and Biodiversity

Broad-scale biogeography of species is poorly studied in the assessment area. Distributions of locally endemic species can result from habitat loss, overall scarcity of suitable environments, or other factors. Apparent peripheral, disjunct, and scattered distributions of some species may be an artifact of the location and size of the area of interest. Species such as boreal owl appear as disjunct populations because of breaks in distributions of suitable environments or incomplete sampling; smaller and more isolated disjunct populations are likely more susceptible to local declines or extinctions. Locally endemic species or subspecies often are highly habitat-specific, such as Coeur d'Alene salamander. Most geographic areas in the Basin have at least some unique species although many species overlap several areas. Some species are closely associated with single biophysical factors, although many species are likely correlated with multiple factors.

Identifying groups of species with such ecological functions may be more useful for management of Federal lands in the assessment area than attempting to identify individual keystone species.

Butterflies constitute a portion of the biodiversity in the Basin.

The project mapped centers of concentration of species rarity and endemism and high biodiversity. Centers of concentration were mapped separately for plants and for animals. Locations with three or more centers of concentration of the two types mentioned defined smaller "hot spots" for plants and animals combined (**map 14**). Twelve hot spots of species rarity and endemism and seven hot spots of high biodiversity were mapped. Additional hot spots may be identified at finer levels of geographic resolution than we used in this project; several likely occur in southern Idaho.

Implications for Ecosystem Management

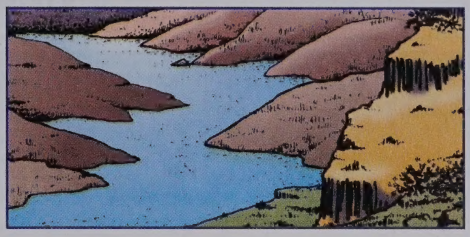
Understanding functions is critical to crafting appropriate ecosystem management guidelines; the fate of individual species is only one facet of terrestrial ecology conservation. Identifying groups of species with such ecological functions may be more useful for management of Federal lands in the assessment area than attempting to identify individual keystone species. The major ecological functions that managers may wish to address in ecosystem management pertain to species that contribute to major biomass, herbivory, nutrient cycling, interspecies relations, soil productivity, wood decomposition, and water quality. The species-environment relations database provides a means of identifying such species by vegetation type, as well as a means of prioritizing species for study.

Natural areas on Federal lands total nearly 29 million acres in 26 land allocation categories. The size of existing natural areas might be suitable for supporting at least small populations of at least 70 percent of vertebrate species. Natural areas of various kinds might be "realigned" or enhanced to better coincide with hot spots of species rarity and endemism and hot spots of high biodiversity. Criteria for selection of new natural areas might be based on consistent ecological themes. The hot spots identified highlight only major locations, so conserving these areas alone should not be assumed to meet the needs of species endemism, rarity, and biodiversity in the Basin.

A species-by-species approach to management of all at-risk species is not advocated, nor is a coarse-filter approach that assumes all associated species are conserved if very gross vegetation features are provided. Many of the species on lists can be assessed in groups or included in broader considerations of ecosystem processes and functions. Inventories, where desired, could aim at gathering information for many species simultaneously, and management guidelines could address their collective habitat and environmental requirements or locations of joint occurrence.

Some policy questions and issues cannot be addressed at the broad regional scale. Additional work is necessary for (1) further describing historical trends and current conditions and threats for species at finer scales of resolution than this current study affords, and (2) collecting basic scientific knowledge on life history, ecology, and distribution of many species. About 86 percent of arthropods, 67 percent of fungi, and 51 percent of mollusk species estimated to occur in the assessment area have not been studied, surveyed, or, in some cases, even identified. Much inventory and basic systematics work remains to be done on these groups. Soil micro-organism groups and microbiotic (soil) crusts of the assessment area, although critical for maintaining soil productivity, are poorly known and little studied.

AQUATIC SPECIES AND HABITATS



The status of aquatic ecosystems in the Basin is influenced by both natural and human processes. The geologic and geomorphic processes described earlier formed and continue to affect the Basin. In concert with the underlying physical environment, these processes establish the template and constrain the successional pathways for aquatic habitats and their associated communities. Similarly, natural fluctuations in the marine environment from variation in atmospheric and ocean circulation patterns influence the productivity of anadromous fish stocks and may temporarily mask changes in freshwater habitats.

Aquatic analyses took place at the subbasin, watershed, and subwatershed level (**figure 10**). There are 164 subbasins in the project area, averaging just under 900,000 acres. The 2,562 watersheds average about 56,000 acres, while the 7,467 subwatersheds average about 19,000 acres.

Results of survey information and tests of relations among habitat features, landscape features, and disturbance variables reinforce the evidence that streams within the assessment area have been significantly affected by human activities. Resources affected include both riparian vegetation and instream habitat.

Water Quality

The U.S. Environmental Protection Agency estimates overall water quality impairment within the Basin. This estimate appears to be modest in comparison to total length of streams within the assessment area (**table 5**). Because these estimates are based on existing and accessible data from local state and Federal monitoring programs, they likely do not reflect the actual extent and distribution of impairment. Most streams in the region are now fully or over-appropriated; irrigation is the primary off-stream use of water in the Basin.

Riparian Areas

Riparian vegetation is a critical component of aquatic ecosystem integrity. A Basin-wide analysis of riparian vegetation found significant changes, including a widespread decline in shrublands in the riparian zones. Shrublands predominantly shifted to forests and herblands through

The integrity of riparian vegetation and its extent along rivers has been changed and fragmented throughout the Basin in response to forest conversion and streamside disturbance.

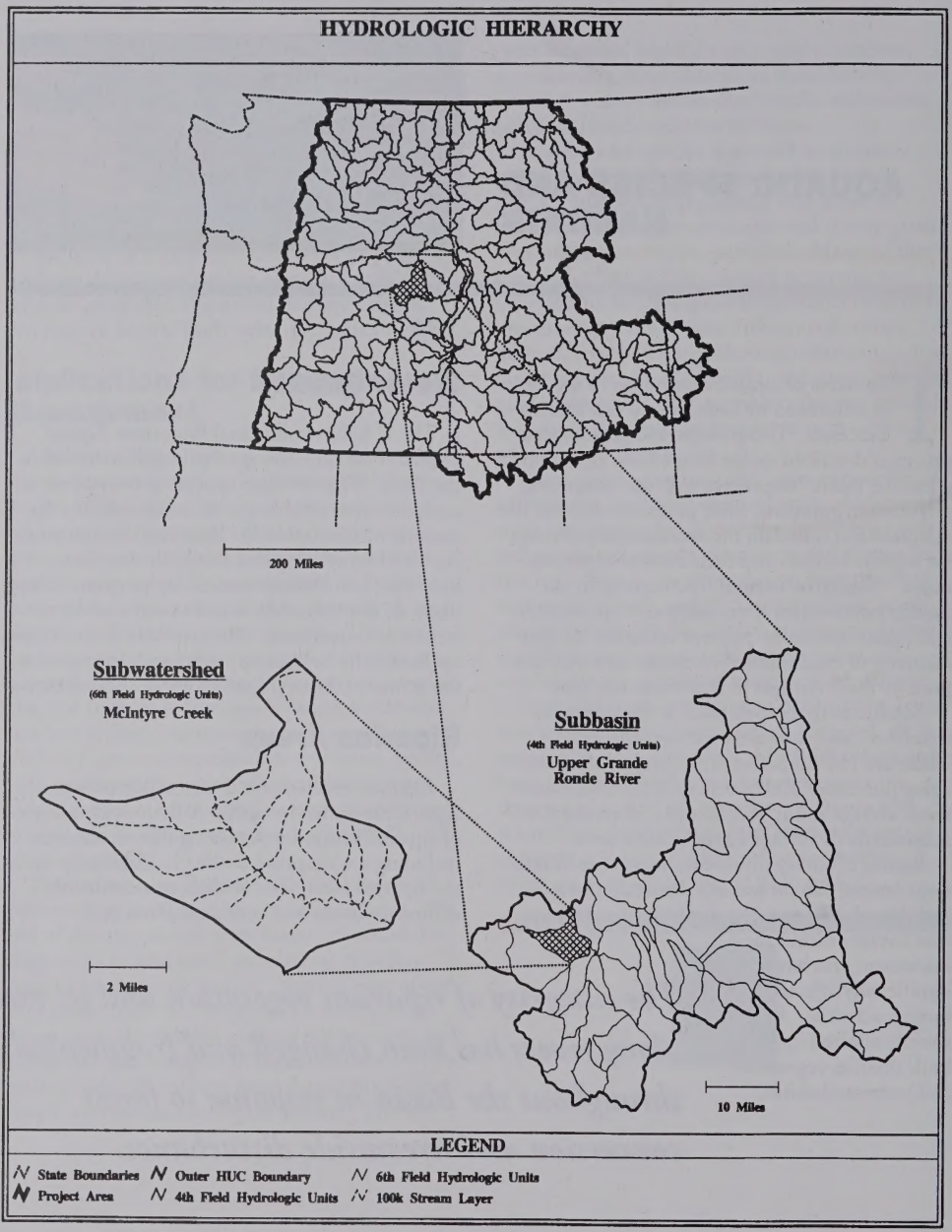


Figure 10—An example of hydrologic hierarchy from subwatersheds to subbasins.

Table 5—Water quality impaired waters reported by the states and the Environmental Protection Agency as miles of streams and rivers in the portions of states within the Interior Columbia Basin Ecosystem Management Project assessment area.

	Total stream miles	Any impairment	Temperature impairment	Nutrient impairment	Sediment/ siltation/ turbidity impairment	Flow impairment
Oregon (1994/96)	75,186	8,123	7,358	280	948	1,263
Forest Service		2,528	2,464	0	320	134
BLM		646	570	49	65	78
Washington (305b)	49,150	3,962	2,815	33	No Data	2,551
Forest Service		578	204	0	No Data	446
BLM		26	14	0	No Data	16
Idaho (303d)	98,984	10,024	2,632	3,459	8,812	2,714
Forest Service		3,000	455	306	2,568	478
BLM		1,350	513	391	1,187	506
Montana (303d)	31,317	3,912	1,051	1,138	3,034	1,791
Forest Service		1,360	271	99	1,053	556
BLM		70	20	10	56	45
Wyoming (303d)	4,785	71	0	0	46	0
Forest Service		39	0	0	35	0
BLM		2	0	0	2	0
Nevada (303d)	6,835	175	161	14	0	0
Forest Service		11	1	9	0	0
BLM		48	48	0	0	0
TOTALS						
All States	**266,257**	**26,266**	**14,017**	**4,922**	**12,840**	**831**
Forest Service [1]		**7,515**	**3,395**	**414**	**3,976**	**1,431**
BLM		**2,142**	**1,164**	**450**	**1,311**	**646**

[1]The Utah Department of Environmental Quality reports no impaired streams or rivers within the project area in Utah.

succession or disturbance. Forests, woodlands, and herblands increased in area or stayed approximately the same. Cottonwood, aspen, and willow, typically riparian-associated species known to have significantly declined, are included in the forest class but are likely masked by the dominance of other species in this class. There was a significant decrease of these cover types in the Snake Headwaters and Columbia Plateau. Significant increases in woodlands—attributed to shrubland conversion to juniper stands—occurred in the Northern Great Basin, Blue Mountains, and Columbia Plateau. The integrity of riparian vegetation and its extent along rivers has been changed and

fragmented throughout the Basin in response to forest conversion and streamside disturbance.

The sufficiency of interim riparian habitat conservation areas (RHCAs) to maintain ecological functions and prevent undesirable cumulative effects is a subject of both social and scientific debate. Interim RHCAs in the range of anadromous fishes and bull trout are prescribed at 300-foot-minimum widths for fish-bearing streams to maintain stream function and prevent sediment inputs from nonchannelized sources. A review of the literature indicates that this width is likely sufficient to provide for most riparian functions with a margin for error depending on the intensity and extent of activities within a RHCA. The likelihood of disturbance resulting in discernible instream effects increases as adjacent slopes become steeper. Thus, greater protective measures to protect or rehabilitate riparian function and structure on steeper slopes may be required to prevent or reduce in-stream effects.

Taken in aggregate, management of stream and riparian systems on forestlands is more restrictive and ecologically more effective than management of riparian areas where agriculture and urban or industrial land uses are dominant. No state within the Basin has enacted an agricultural practices act explicitly protecting riparian vegetation. If the goal is to ensure survival of salmon and many native fishes in the long term, improved protection of riparian areas in agricultural lands is essential.

Dams and Diversions

Construction of dams and reservoirs and their complex effects on migration is an important threat to the persistence of salmon and steelhead trout within the Basin. Construction of large dams began about 1900, and has since greatly reduced the range of migrating fish. Today there are at least 1,239 large dams in the assessment area, each with storage capacity in excess of 62,000 cubic meters. The total, including small dams, could be several times larger. Most of the thousands of small dams in the Basin do not have fish passage facilities, yet the full extent to which these dams impede migration or affect spawning and rearing habitats of fishes has not been documented. Even with fish passage facilities, detrimental effects from dams occur as a result of direct mortality of juveniles in turbines and bypass systems and indirect mortality owing to physiological stress, increased susceptibility to predators, and the inability to find routes around dams and through slack water.

Although much of the highest-quality habitat for these anadromous fish probably remains in the Central Idaho Mountains, no strong populations persist there largely due to passage mortality in migration corridors. These corridors provide a critical link maintaining the complex life histories of other species as well. For example, non-anadromous species that retain migratory life-history patterns such as bull, redband, Yellowstone cutthroat, and westslope cutthroat trout may move repeatedly between small rivers and headwater streams.

Roads

The effects associated with roads reach beyond their direct contribution to disruption of hydrologic function and increased sediment delivery to streams. Roads provide access, and the activities that accompany access magnify the negative effects on aquatic systems beyond those solely from roads themselves. Strong populations of fish are present in some roaded subwatersheds. This relationship between population status and roads requires more investigation to be fully understood.

Increasing road density is correlated with declining aquatic habitat conditions and aquatic integrity and is associated with declines in the status of four non-anadromous salmonid species.

While roads pose many risks to ecosystem functioning, they provide benefits to humans through access for recreation and other land uses.

Increasing road density is correlated with declining aquatic habitat conditions and aquatic integrity and is associated with declines in the status of four non-anadromous salmonid species. The discussion of the relation of roads to fishes often involves three themes: (1) the belief that road-building practices have improved in the last decade to the point we should not worry about the effects of roads on aquatic systems; (2) the legacy of past road building is so vast and road maintenance budgets so low that the problems will be with us for a long time; and (3) the belief that the correlation of road density to fish habitat and fish population is not strong.

An intensive review of the literature concludes that increases in sedimentation are unavoidable even using the most cautious roading methods. Roads combined with wildfires accentuate the risk from sedimentation. The amount of sedimentation or hydrologic alteration from roads that streams can tolerate before there is a negative response is not well known. It is not fully known whether building roads to reduce fire risk causes greater risk to aquatic systems than realizing the potential risk of fire.

In addition, the ability of the Forest Service and BLM to conduct road maintenance has been sharply reduced because of declining budgets. This is resulting in progressive degradation of road drainage structures and a potential increase in erosion. Most problems are with older roads located in sensitive terrain and roads that have been essentially abandoned but are not adequately configured for long-term drainage.

Pools

Along with the loss of riparian vegetation, human activities have combined to create major decreases in pool habitat. Pools provide many key functions, including rearing habitat for juvenile fish, resting places, overwintering areas, and refuges from floods, drought, and extreme temperatures.

Pool frequency (large pools and all pools) is inversely correlated with road density and management intensity. The magnitude of decreases in deep pools is substantial and extensive across the Basin. Most unmanaged streams either have retained pools or have improved pool habitat during the last 55 to 60 years.

A factor likely to be important in controlling pool frequency in the Basin is the abundance of instream wood. Wood effectively stabilizes channels, influences sediment routing, provides a major component of the instream organic matter, provides cover for fish and habitat for invertebrates, and increases overall channel complexity. Protecting sources of instream wood for streams is important: there is not much wood to begin with, it plays a critical role for pool formation and habitat conditions, and wood frequency is sensitive to management practices.

Another important aspect of habitat quality that apparently is influenced by management is the amount of fine sediment (sediment less than 6 mm) on channel beds. Road density significantly affects surface fines and corroborates the link between forest management practices and channel sediment characteristics.

The composition, distribution, and status of fishes within the Basin is very different than it was historically.

Status and Distribution of Fishes

A total of 142 fish taxa were reported within the Basin. Fishes were considered at three levels listed in order of increasing detail: (1) fish species assemblages, from which richness and diversity indices were calculated; (2) 38 taxa considered sensitive, threatened, endangered, or of special concern; and (3) key salmonids [bull, westslope cutthroat, Yellowstone cutthroat, and redband trout; steelhead trout; and ocean-type (age-0 migrant) and stream-type (age-1 migrant) chinook salmon]. This analysis was based on both a

The bull trout is one of seven key salmonids in the Basin.

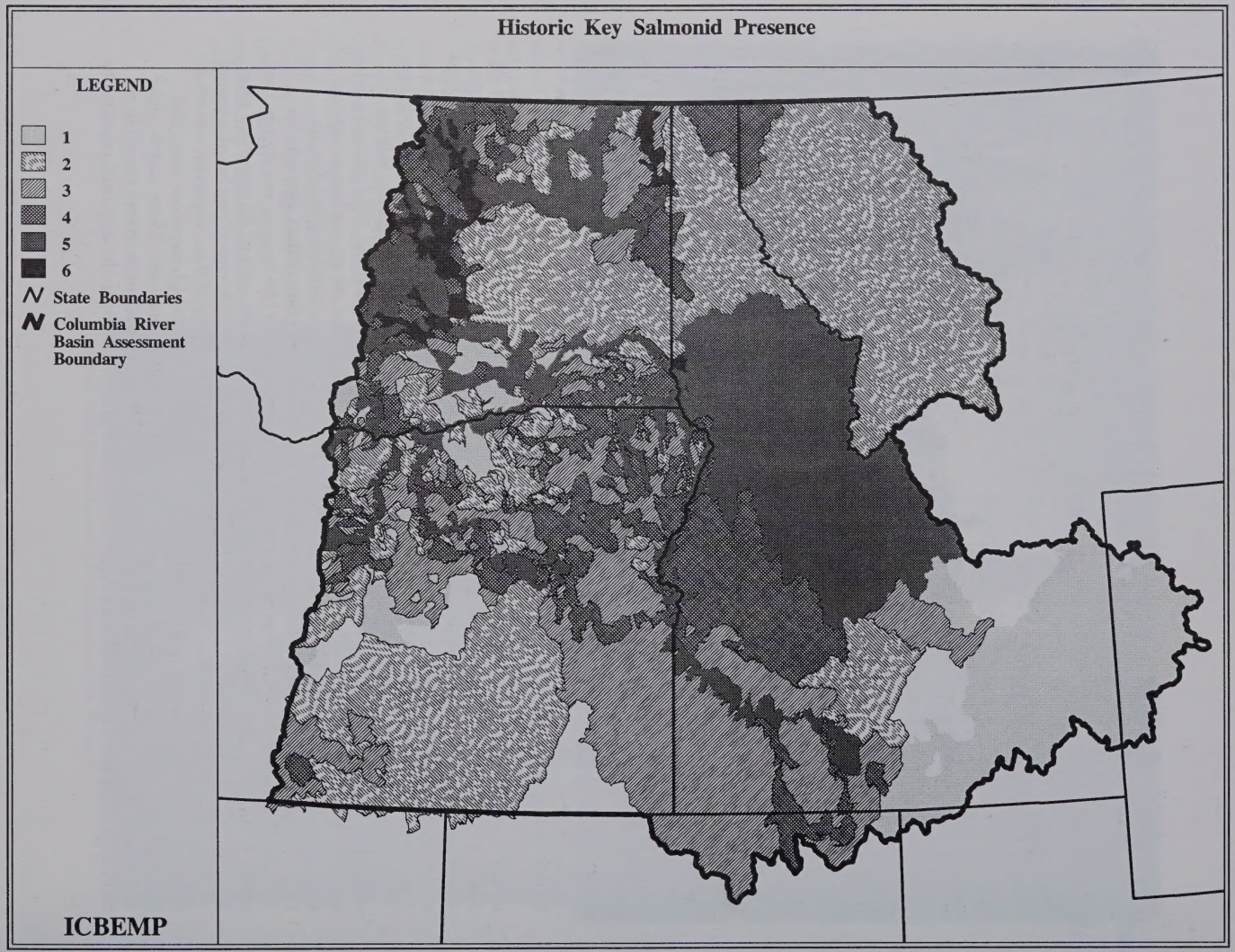
The Metolius River in central Oregon has clear, cold water flowing from springs that help create excellent habitat for Bull trout.

summary of known distributions and the prediction of distributions and status for select species throughout the entire assessment area and was supported by information collected through more than 140 biologists working throughout the region.

Aquatic habitat fragmentation (impassable obstructions—including dams, temperature increases, and water diversion) and simplification (channelization, removal of woody debris, channel bed sedimentation, removal of riparian vegetation, and water flow regulation) have resulted in a loss of diversity within and among native fish populations.

The composition, distribution, and status of fishes within the Basin is very different than it was historically. Some forms are extinct and many others, especially anadromous fish, are extirpated from large portions of their historical range. Although several of the key salmonids remain distributed through much of their historical ranges (notably the cutthroat trouts and interior redband trout), declines in abundance, the loss of important life histories, local extinctions, and fragmentation and isolation of high-quality habitats are apparent (**maps 15 and 16**). Wild chinook salmon and steelhead trout are approaching extirpation in a major part of the remaining distribution.

With the exception of the Central Idaho Mountains, Snake Headwaters, and perhaps the Northern Cascades, most of the important areas for the key salmonids exist as patches of scattered watersheds. Many of these important watersheds are associated with high-elevation, steep, and more erosive landscapes. These may be more extreme or variable environments contributing to higher variability in the associated populations



Map 15—Historic key salmonid presence.

Map 16—Current key salmonid presence.

Map 17—Aquatic strongholds and low road densities.

and higher sensitivity to watershed disturbances. Even with no further habitat loss the fragmentation and isolation may place remaining populations at risk. Risks could be aggravated with further development. The distribution of steelhead trout, for example, has decreased from historical range and known or predicted strongholds are few and far between.

Although less is known about the rare and sensitive fish taxa than the seven key salmonids, analyses of existing distribution and reviews of available literature provide insights about common threats and appropriate management needs. Many of these taxa occur in isolated areas of the Columbia River basin, in isolated subbasins of the Great Basin, or are restricted to the upper Klamath Basin. They typically occur in subbasins with only 1 or 2 native fish species present and in very restricted areas, often occupying 1 or 2 small habitat patches within subwatersheds (averaging 8,000 hectares in size). Consequently, broad- or mid-scale assessments that focus on high native species diversity may not adequately describe their distributions.

Some 15 previous efforts to identify special emphasis watersheds for conservation of aquatic resources and ecosystem function in the Basin were examined to address whether habitat criteria or population presence and status are better indicators for such special fish emphasis watersheds. Fish population strength was evaluated to identify the best remaining habitats within the Basin by focusing on subwatersheds with designated strong populations of seven key salmonids. This approach has the distinct advantage of recognizing the biological building blocks necessary to maintain and rehabilitate fish populations in the Basin. More than 27 percent of FS- and BLM-administered lands in the Basin contain strongholds (40 percent of Forest Service and 4 percent of BLM). These subwatersheds contain large areas of unroaded land (**map 17**).

Implications for Ecosystem Management

Although much of the native ecosystem has been altered, core areas remain for rebuilding and maintaining functional native aquatic systems. Even though they are reduced in numbers and distributions, native trouts remain some of the most widely distributed taxa within the Basin. This suggests that although serious problems exist, particularly in the larger rivers and in the low-elevation agricultural and rangelands, the situation is somewhat better in the forested lands. Conditions remain best in areas that have experienced the least human-caused disturbance. Most of the areas exhibiting high-aquatic integrity fall within forested areas, with the exception of areas inherently high in native-species richness near the southern edge of the Basin.

Although much of the native ecosystem has been altered, core areas remain for rebuilding and maintaining functional native aquatic systems.

The largest areas of contiguous watersheds supporting strong populations of key salmonids are associated with the major river subbasins found in the Central Idaho Mountains, the Snake Headwaters and the Northern Cascades. Important but more restricted areas are also found in the Blue Mountains, Upper Clark Fork and the Northern Glaciated Mountains. Each of the key salmonids supported some known or predicted strong populations (**table 6**).

The core for maintaining and restoring much of the biological diversity associated with fishes still exists. Conservation and restoration of important habitats for key salmonids could provide habitat for associated species and will sustain

Table 6—Historical and occupied range and habitat status for key salmonids within the Basin Assessment area.

Species	Historical range occupied	Occupied range classed as strong	Strongholds in wilderness	Strongholds on FS/BLM	Depressed on FS/BLM	Sensitive to FS/BLM uses
	percent					
Bulltrout	45	13	55	95	82	Yes
Westslope cutthroat	85	25	44	94	65	Yes
Yellowstone cutthroat	66	35	19	70	46	Yes
Redband	69	22	8	56	58	Yes
Steelhead	46	1	9	70	61	Yes
Stream-type chinook	28	<1	50	88	77	Yes
Ocean-type chinook	30	15	0	20	25	minor influence

important processes that influence structure and function within these systems.

Restoring or maintaining the integrity of migration corridors will be challenging. Restoration and management of watersheds only on Federal lands will not be sufficient; river corridors surrounded largely by private lands are a particularly important part of fish habitat networks. Connections and habitat provided by larger river systems are critical to maintenance of anadromous populations. Rehabilitation of depressed populations cannot rely on habitat improvement alone but requires a concerted effort to address causes of mortality in all life stages. These include freshwater spawning and rearing, juvenile migration, ocean survival, and adult migration.

The introduction of non-native species and hatchery-propagated native species has influenced aquatic community composition. Containing non-natives will provide benefits that go beyond system integrity.

Protection and maintenance of system integrity and functioning will require innovative approaches. Simple solutions such as setting aside small, scattered watersheds probably will not be adequate for the persistence of even current distributions and diversity. If maintenance or restoration of the integrity of aquatic ecosystems is an important goal, dramatic and decisive action is required to stop further alterations and restore areas that are degraded.

If maintenance or restoration of the integrity of aquatic ecosystems is an important goal, dramatic and decisive action is required to stop further alterations and restore areas that are degraded.

While watershed protection is an effective management approach, evidence suggests that system integrity can be maintained in some intensively managed areas. It is unclear, however, whether intensively managed areas with high integrity are anomalies, regions where the effects on streams lag behind the changes on land, or are areas where intensive management and fish can coexist.

Additional research will help to design management strategies to accomplish fish and habitat goals. The collective knowledge of status, distribution, and habitats for fishes is incomplete. Existing knowledge reflects the historical focus of fish management and research agencies on production and yield, recreational fishing opportunity, and high-profile species rather than on biotic integrity or species conservation. Sampling methodologies are poorly developed, inventories are incomplete, and reference standards are virtually non-existent. The development of consistent, reliable, large-scale species inventories will be critical for long-term management and evaluation of aquatic ecosystems.

Field experiments can be developed to provide information on the spatial dimensions (that is, width, length, depth, space and continuity) of riparian buffer zones necessary to achieve single and multiple ecological and/or social objectives as well as how well they continue to function through time.

Three types of studies can contribute to the evaluation of hydrologic and geomorphic disturbance effects. First, field surveys are needed to assess the effect of historical events such as fires and large floods. Second, intensive, opportunistic surveys could be undertaken during and following these rare events. Third, the resilience of riparian and aquatic ecosystems to changes in the magnitude and frequency of extreme events could be tested using human-caused events (such as regulating levels of dams, reservoirs, and irrigation withdrawal).

ECOSYSTEM INTEGRITY

The previous sections described existing conditions and trends from a variety of resource perspectives. This section describes the overall status of Basin ecosystems by combining that information to evaluate ecosystem integrity—the degree to which all ecosystem components and their interactions are represented, functioning, and able to renew themselves. The integrity of ecosystems encompasses both social and biophysical components; the health of the Basin's people and economy are not a separate issue from the health and integrity of other ecosystem components. Maintaining the integrity of ecosystems is assumed to be the overriding goal of ecosystem management.

Ecological integrity refers to the presence and functioning of ecological components and processes. The basic components of ecological integrity include the forest, range, and aquatic systems with a hydrologic system that overlays the landscape as a whole. The counterpart to ecological integrity in social and economic terms is resiliency (measured at the county level), which in the context of ecosystem management reflects the interests of people to maintain well-being through personal and community transitions.

Following is an overview of the integrity of systems in the Basin. Based on the data sets and analysis conducted through the project, each of the 164 subbasins (averaging approximately 900,000 acres each) was rated based on their relative differences, as having high, medium, and low ecological integrity for forestlands, rangelands, forestland hydrology, rangeland hydrology, and aquatic systems. This analysis included all ownerships within the Basin.

These integrity and resiliency ratings are initial estimates based on available information and on broad proxies for various processes. Some of the proxies for ecological measures, for example, reflect structure rather than the underlying process. These represent the best approximations at this broad extent for the underlying processes available at this time. Absolute levels of integrity or resiliency within the Basin have not been measured. Rather, these ratings represent the first attempt at estimating integrity and resiliency at this spatial level and undoubtedly will be refined as additional information becomes available.

Ecological Integrity

A terrestrial system that exhibits high integrity is a mosaic of plant and animal communities consisting of well-connected, high-quality habitats that support a diverse assemblage of native and desired non-native species, the full expression of potential life histories and taxonomic lineages, and the taxonomic and genetic diversity necessary for long-term persistence and adaptation in a variable environment. Areas exhibiting the most elements of a system with high integrity were rated as "high" and those with the fewest elements were rated "low"; the "medium" rating fell in between.

Forestland integrity ratings were estimated for each subbasin if the forested vegetation component was at least 20 percent of the area of the

subbasin, while rangeland integrity ratings were estimated if the rangeland potential vegetation types within a subbasin comprised at least 20 percent of the area of the subbasin. This resulted in 112 subbasins with a forest integrity rating, 86 subbasins with range integrity ratings, and 39 subbasins rated for both.

Forestland Integrity—Measures of forestland integrity include such elements as: (1) consistency of tree stocking levels with long-term disturbances typical for the forest types present, (2) the amount and distribution of exotic species, (3) the amount of snags and down woody material present, (4) disruptions to the hydrologic regimes, (5) the absence or presence of wildfire and its effect on the composition and patterns of forest types, and, (6) changes in fire severity and frequency from historical (pre-1800s) to the present.

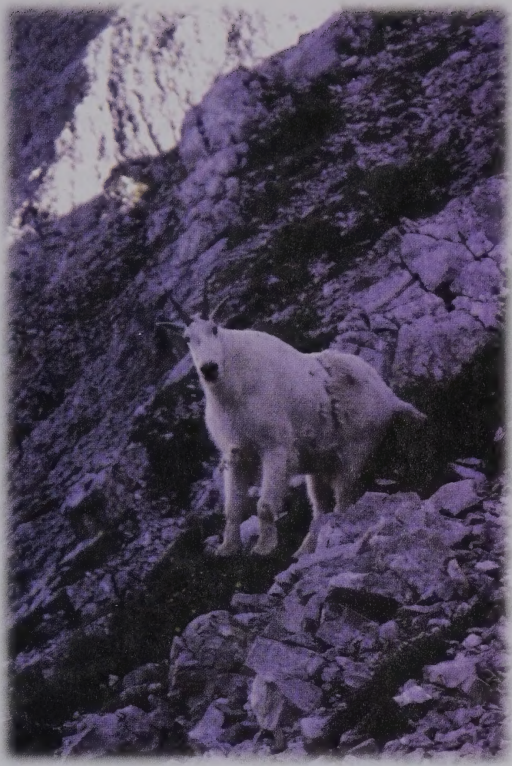
Rangeland Integrity—Measures of rangeland integrity include such elements as: (1) grazing influences on vegetation patterns and composition, (2) disruptions to the hydrologic regimes, (3) expansion of exotic species, (4) changes in fire severity and frequency, (5) increases in bare soils, and (6) expansion of woodlands into herblands and shrublands.

Hydrologic Integrity—A hydrologic system that exhibits high integrity is a network of streams, along with their ground water ecosystems, within the broader landscape where the upland, floodplain, and riparian areas have resilient vegetation, where capture, storage, and release of water limits the effects of sedimentation and erosion, and where infiltration, percolation, and nutrient cycling provide for diverse and productive aquatic and terrestrial environments. Due to a lack of consistent data on stream characteristics such as width, depth, and streambed materials and arrangement, hydrologic integrity was estimated based on disturbance sensitivity and recovery potential of watersheds, plus the amount and type of past disturbance.

Watersheds with high impact (disturbance) and low recovery potential have higher probabilities of containing altered hydrologic functions than other areas, and are consequently classified as low integrity. Conversely, areas with low relative effect from mining, dams, roads, cropland conversion, and grazing and which also have high recovery potentials are considered to have the highest probable hydrologic integrity.

Aquatic Integrity—An aquatic system that exhibits high integrity has a mosaic of well-connected, high-quality water and habitats that support a diverse assemblage of native and desired non-native species, the full expression of potential life histories and dispersal mechanisms, and the genetic diversity necessary for long-term persistence and adaptation in a variable environment. Subbasins exhibiting the greatest level of these characteristics were rated high, those exhibiting the least were rated low, with medium ratings in between.

Terrestrial Community Types—The counterpart for estimating the integrity of terrestrial habitat was developed by comparing pre-Euro-American settlement conditions with those existing today. The resulting departure values show how much each subbasin has undergone broad-scale habitat changes in forest and rangelands. Risk to species persistence was assumed to increase substantially when the availability of current habitat fell below 75 percent of that available historically.



Map 18—Composite ecological integrity ratings.

Composite Ecological Integrity

The five component integrity ratings (forestland, rangeland, forest and rangeland hydrologic, and aquatic systems), along with other information collected by the project, were used to develop an overall estimate of ecological integrity of each subbasin. Composite integrity was estimated by comparing the component integrity ratings and knowledge of actual on-the-ground conditions. Currently, 16 percent of the Basin falls in the relatively high class, 24 percent in the moderate, and 60 percent in the low ecological integrity class (**figure 11; map 18**).

Much of this low category includes lands used for agriculture and grazing; a low rating does not imply low productivity. The rating system emphasizes ecological processes and functions and thus has a tendency to rate human-altered systems lower than systems dominated by more natural processes. Eighty-four percent of the systems with high integrity are on FS- and BLM-administered lands while 39 percent of the low integrity systems are on FS- and BLM-administered lands.

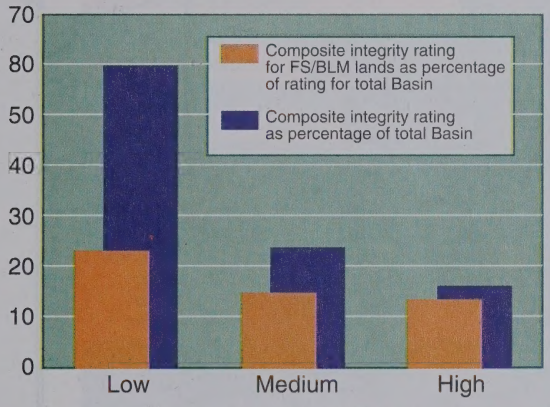


Figure 11—Integrity Basinwide and for FS- BLM-administered lands.

While this information is useful from a Basinwide perspective, it does not describe what geographic areas of the Basin have higher or lower integrity. For this reason, subbasins were examined to determine whether they clustered into groups with common conditions, risks, and opportunities. This analysis was conducted separately for forested landscapes and non-forested (range) landscapes; some subbasins contain both range and forested landscapes, which may be in very different ecological condition.

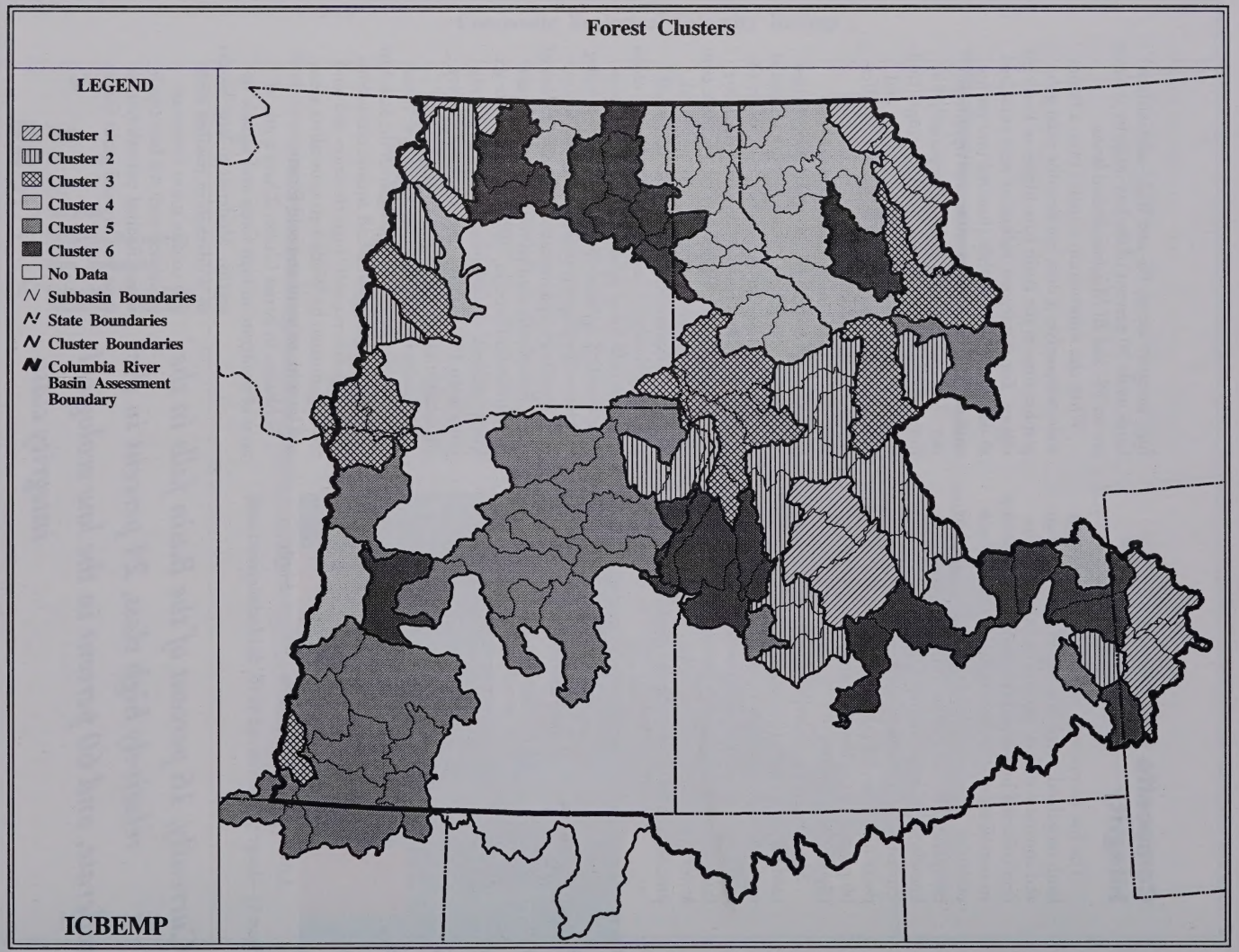
For the cluster analysis, conditions within forest clusters and range clusters are summarized for the entire landscape, including both terrestrial and aquatic components. Within any cluster, the predominant conditions are an average —some locations within the cluster may have specific conditions that are better or worse than indicated.

Forest Clusters—Subbasins with at least 20 percent of their area composed of dry forest, moist forest, or cold forest potential vegetation groups were classified as forest clusters. Relations among variables reflecting vegetative conditions, hydrologic sensitivity, and human-caused disturbance of native forests were studied to identify dominant patterns and differences. What emerged were six forest "clusters" of subbasins with similar conditions (**map 19**). **Table 7** shows some of the key characteristics of each cluster.

Subbasins in Forest Cluster 1 represent those that are most intact ecologically, with the least loss of integrity in both forest and aquatic ecosystems. They are predominantly high elevation and tend to be dominated by Wilderness or roadless areas, and by cold, or moist and cold forests.

Subbasins in Forest Cluster 2 have a mix of areas of moderate-to-high forest and aquatic integrity. Moderate to large blocks of Wilderness or roadless areas and cold or moist forests are associated with the best conditions. Roaded non-wilderness areas and dry and moist forests

Currently, 16 percent of the Basin falls in the relatively high class, 24 percent in the moderate, and 60 percent in the low ecological integrity class.



Map 19—Subbasins grouped in Forest Clusters.

Table 7—Summary of Characteristics of Forest Clusters (all lands).

Variable	Forest Cluster 1	2	3	4	5	6
	percent of area					
Ownership						
BLM/FS	80	86	40	58	50	35
Other	20	14	60	42	50	65
Potential Vegetation Groups						
Dry Forest	13	26	22	14	43	23
Moist Forest	23	25	33	67	6	16
Cold Forest	47	30	15	7	4	9
Dry Grass/Shrub	7	11	6	3	24	15
Cool Shrub	3	3	1	1	8	11
Other	8	5	24	8	15	26
Forested Vegetation Groups (% of forested area in each)						
Dry Forest	16	37	55	18	81	51
Moist Forest	27	27	52	73	11	21
Cold Forest	57	36	13	9	8	28
Road Density Classes						
Low or none	85	62	32	20	22	36
Moderate or higher	15	38	68	80	78	64
Cropland/pasture	0	3	20	2	11	21
<12" annual precipitation	1	4	2	3	14	14
Fire frequency change	37	60	66	51	60	60
Fire severity increase	36	50	57	47	35	36
High wildland/urban fire interface risk	0	17	6	1	29	10
Moderate wildland/urban fire interface risk	29	61	36	13	30	23
Change in juniper woodland	0	0	0	0	0	0
Forest Integrity						
Low	0	10	67	86	79	59
Moderate	0	43	33	10	21	17
High	100	47	0	4	0	24
Range Integrity						
Low	0	29	100	57	100	66
Moderate	61	48	0	43	0	35
High	40	23	0	0	0	0
Aquatic Integrity						
Low	5	0	8	54	52	87
Moderate	38	59	85	46	44	13
High	58	41	7	0	4	0
Hydrologic Integrity						
Low	0	4	47	12	39	76
Moderate	4	30	49	54	41	17
High	96	66	4	34	20	7
Composite Ecological Integrity						
Low	0	0	4	83	96	100
Moderate	0	3	96	17	4	0
High	100	97	0	0	0	0

Source: ICBEMP GIS data (converted to 1 km^2 raster data).

often coincide with more altered vegetation conditions.

Subbasins in Forest Cluster 3 are represented by aquatic ecosystems that are in relatively good condition, but have forests that are in highly altered and poor condition. Wilderness or roadless areas play a relatively insignificant role, and roading is moderate to extensive. Forests in this cluster are dominated by moist and dry forest potential vegetation groups. The moderately to highly productive forests in this cluster appear to have substantially changed structure, composition, and fire regime.

Moist Forest. Relatively healthy, diverse, open stand of western larch, Douglas-fir, and grand fir. There is almost no western white pine because of the effects of blister rust. Restoration would likely try to increase the amount of western white pine and manage for these types of vegetation structures.

Subbasins in Forest Cluster 4 have relatively low forest integrity and low or moderate aquatic integrity. The highly altered forests are mostly composed of the productive moist forest potential vegetation group. They tend to have the highest road densities in the project area, with few Wildernesses or roadless areas.

Subbasins in Forest Cluster 5 have low forest integrity and low or moderate aquatic integrity. Forest Cluster 5 is dominated by dry forests that are extensively roaded and have little, if any, Wilderness. Forest structure and composition have been substantially altered from historical conditions. These subbasins show large changes in fire frequency but less change in fire severity.

Subbasins in Forest Cluster 6 are in relatively poor condition from both a forest and an aquatic perspective, with especially fragmented aquatic systems and the lowest hydrologic integrity of any forest cluster. Forests in this cluster are composed

Moist Forest. Relatively unhealthy, closed stand of Douglas-fir and grand fir. Because of dominance by shade tolerant species that are susceptible to mortality from insects and disease, these stands are at high risk. They also are dense and have high accumulations of down, woody fuels and deep litter/duff layers. Consequently they are at risk for intense fires. Because the pattern is continuous the fires can be extensive and large.

Dry forest. Unhealthy forest with multiple layers and large, down dead fuels and deep litter and duff cover. The lower layers of small shade tolerant trees are susceptible to insect, disease and stress mortality. They provide a ladder that will carry fires into the crowns of the scattered large trees. Ecosystem management treatments would likely harvest the smaller trees in the overstory and understory, and use prescribed fire to change the character of the forest to look like the next photo.

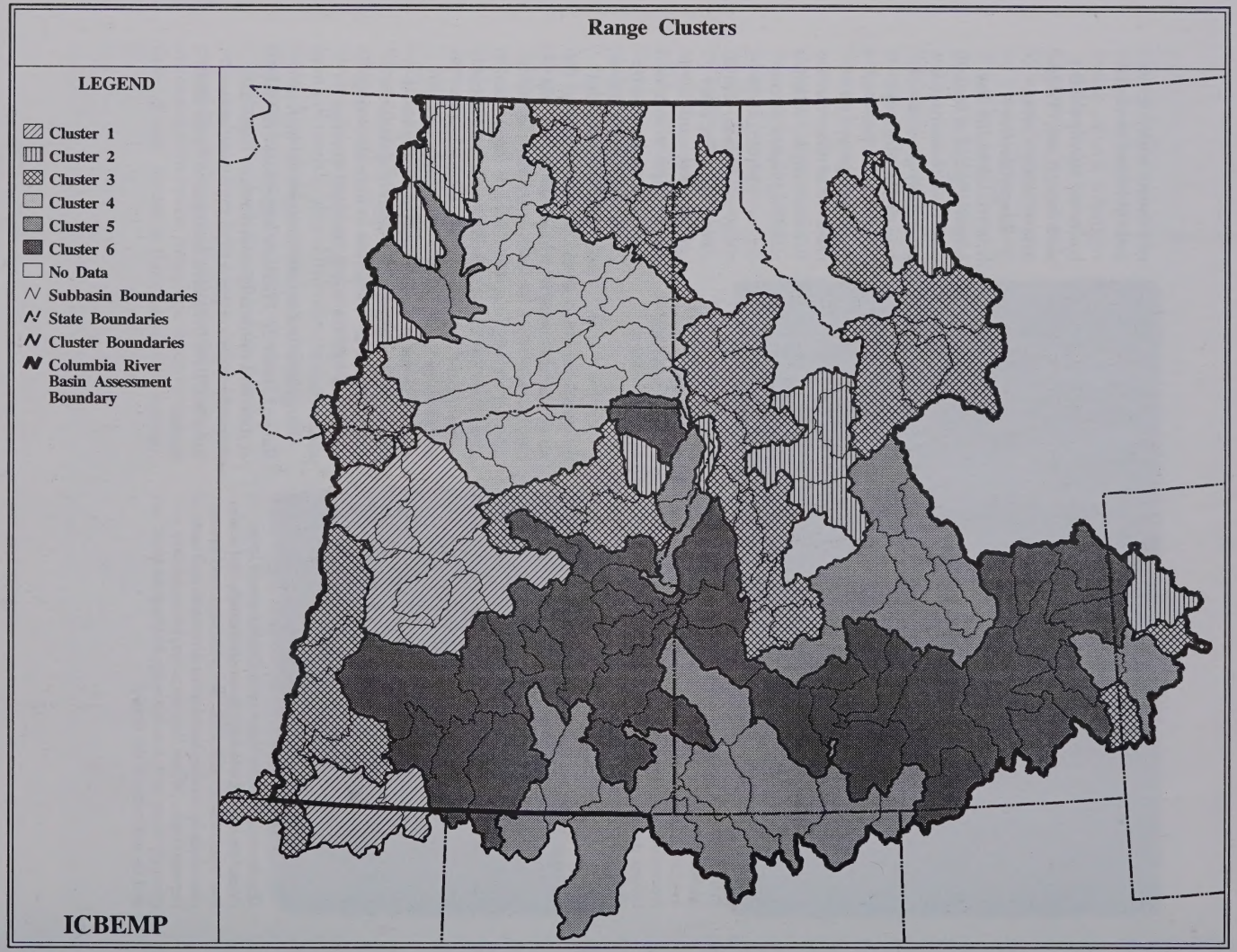
Dry forest. Healthy forest with single layer of large trees, few large down logs, grass understory, and shallow layer of litter and duff. Trees are vigorous because there is little competition for moisture and nutrients between trees. When fires occur in this stand they generally burn with low intensity, in the grass fuels, and do not burn in the crown.

of a variety of dry, moist, and cold forest potential vegetation groups. Subbasins are heavily roaded with little, if any, Wilderness or roadless areas.

Range Clusters— Selected subbasins that historically had at least 20 percent of their area comprising dry grass, dry or cool shrub, woodland, and dry forest potential vegetation groups were classified as range clusters. Relations among variables reflecting vegetative conditions, hydrologic sensitivity, and human-caused disturbance were also used in a way similar, but not identical, to that used for forest clusters. Range cluster analysis identified dominant patterns and differences between subsets of these variables. Six range clusters emerged, where subbasins within clusters were more like each other than subbasins in other clusters (**map 20**). **Table 8** summarizes some of the key characteristics of each range cluster.

Rangeland and aquatic integrity are low to moderate in Range Cluster 1, which is distinguished by large areas of western juniper woodland. These subbasins have high road densities and little area in Wilderness or unroaded categories. Over half the area is managed in range allotments.

Rangeland and aquatic integrity are high in Range Cluster 2. There are large blocks of Wilderness and minimally roaded areas. These dry, forested ranges are generally in the lower elevations and have little area managed as range allotments.



Map 20—Subbasins grouped in Range Clusters.

Table 8— Summary of characteristics of Range Clusters.

Variable	Range Cluster 1	2	3	4	5	6
	percent of area					
Ownership						
BLM/FS	36	81	44	5	75	55
Other	64	19	56	95	25	45
Potential Vegetation Groups						
Dry Forest	29	21	34	8	10	12
Moist Forest	5	33	28	4	5	2
Cold Forest	1	34	14	30	11	4
Dry Grass/Shrub	32	4	4	26	45	50
Cool Shrub	22	1	2	3	20	9
Other	11	7	18	59	9	23
Rangeland Vegetation Groups						
Dry Rangeland	49	34	17	30	61	61
Cool Rangeland	34	8	8	3	27	11
Other	17	58	75	67	12	28
Road Density Classes						
Low or none	20	71	30	62	64	30
Moderate or higher	80	29	70	38	36	70
Cropland/pasture	9	3	14	56	5	17
<12" annual precipitation	23	1	2	51	33	38
Fire frequency change	37	51	67	17	24	17
Fire severity increase	18	47	49	13	16	9
High wildland/urban fire risk interface	32	7	12	0	6	8
Moderate wildland/urban fire risk interface	10	59	33	4	58	39
Change in juniper woodland	+ 12	0	0	0	0	0
Forest Integrity						
Low	100	6	76	79	12	37
Moderate	0	37	15	21	27	43
High	0	57	9	0	61	20
Range Integrity						
Low	100	6	76	100	26	79
Moderate	0	37	15	0	50	21
High	0	57	9	0	24	0
Aquatic Integrity						
Low	39	4	43	84	37	79
Moderate	61	24	50	16	57	18
High	0	72	7	0	6	3
Hydrologic Integrity						
Low	34	6	49	100	7	44
Moderate	66	16	35	0	35	34
High	0	78	16	0	58	22
Composite Ecological Integrity						
Low	100	0	58	97	8	80
Moderate	0	3	32	3	63	20
High	0	97	10	0	29	0

Source: ICBEMP GIS data (converted to 1 km^2 raster data).

Dry, forested ranges in Range Cluster 3 have moderate rangeland integrity and mixed aquatic integrity. These subbasins contain little or no Wilderness or roadless areas. Less than half of the subbasins are managed as public land range allotments. These subbasins are among the most altered forested rangelands of the project area.

Subbasins in Range Cluster 4 have the lowest rangeland and aquatic integrity of all rangelands in the project area. There are no Wildernesses or roadless areas, and range allotments on public lands are minimal. Subbasins in this cluster are distinguished from other clusters because they are composed primarily of cropland and pasture.

Healthy riparian area with relatively dense cover of herb and shrub vegetation along the stream banks and on the adjacent terraces. This system is resilient, has high capacity to store water, and is a buffer for flood events.

Subbasins in Range Cluster 5 are composed of upland shrublands with moderate integrity and mixed aquatic integrity. These subbasins represent the bulk of the high-elevation ranges. They are less developed, less roaded, more remote, and tend to be less disturbed by agricultural conversion or grazing than cropland-dominated subbasins.

Both rangeland and aquatic integrity are low in Range Cluster 6 subbasins. The dry shrubland potential vegetation group dominates upland shrublands. Road densities are relatively high. Most rangelands on public lands in this cluster are managed as range allotments.

In summary, **table 9** highlights the risks to ecological integrity and opportunities to address risks for each of the forest and range clusters.

Unhealthy riparian area with relatively low cover of herb vegetation along the stream banks and on the adjacent terraces. Effects of summer season historic livestock grazing caused the loss of shrubs and compacted the surface soil. The stream cut down in the channel and the water table dropped resulting in a dryer system. This system is less productive, less diverse, will not store as much water, and has low buffering capacity during flood events.

Table 9—Forest Clusters - primary characteristics, risks to ecological integrity, and opportunities to address risks to integrity.

Forest Clusters	Primary characteristics	Primary risks to ecological integrity	Primary opportunities to address risks to integrity
Forest 1	1. Moist and Cold Forest types 2. Minimally roaded 3. High aquatic, forest, hydrologic, and composite integrity	1. Severe fire potential in lower elevations 2. Higher elevations sensitive to soil disturbances (i.e., roading)	1. Prescription of natural or prescribed fire to reduce risks of severe fire 2. Reduction of stocking levels in lower elevations - reductions of fire severity. Maintenance of integrity in higher eleva tions
Forest 2	1. Minimally roaded 2. Mix of high and moderate forest, hydrologic, and aquatic integrity 3. High composite integrity 4. Mix of cold, moist, and dry forest types (nearly equal)	1. Cold forest types sensitive to soil disturbance (i.e., roading) 2. Fire severity in lower elevations and dry forest types 3. Aquatic integrity induced by low forest integrity in dry and moist forest types	1. Reduction of fire threat in lower elevations and manage road densities 2. Improvement of aquatic integrity through improving connectivity 3. Reduction of fire severity through restoration practices
Forest 3	1. Moderately roaded 2. Moderate aquatic and composite integrity 3. Low and moderate forest and hydrologic integrity 4. Dry and moist forest types	1. Fire severity in dry/moist forest types 2. Aquatic integrity at risk in areas of high fire potential 3. Old/late forest structures in managed areas	1. Restoration of forest integrity 2. Maintenance of aquatic and hydrologic integrity 3. Management of road densities
Forest 4	1. Moist forest types 2. Highly roaded 3. Low forest, aquatic, and composite integrity 4. Moderate to high hydro-logic integrity	1. Hydrologic and aquatic systems from fire potentials 2. Late and old forest structures in managed areas 3. Forest compositions - susceptibility to insect, disease, and fire	1. Restoratoion of late and old forest structure in managed areas 2. Connection of aquatic strongholds through restoration 3. Treatment of forested areas to reduce fire, insect, and disease susceptibility
Forest 5	1. Dry forest types 2. Low to moderate aquatic integrity and low forest integrity and low composite integrity 3. Sensitive watersheds to disturbance 4. Highly roaded	1. Fish strongholds from sediment/erosion potential 2. Forest composition and structure, especially old/late 3. Hydrologic integrity due to fire severity and frequency	1. Restoration of forest integrity through vegetation management 2. Restoration of old/late forest structure 3. Restoration of aquatic and hydrologic integrity by reducing risk of fire, insect, and disease and road management
Forest 6	1. Dry forest types 2. Low hydrologic, forest, aquatic, and composite integrity 3. Moderately roaded	1. Forest composition and structures especially old/late 2. Primarily present at finer resolutions	1. Restoration of forest structures 2. Maintenance of the scattered aquatic strong-holds that exist 3. Reduction of risk of fire, insect, and disease

Table 9 (continued)—Rangeland Clusters - primary characteristics, risks to ecological integrity, and opportunities to address risks to integrity.

Range Clusters	Primary characteristics	Primary risks to ecological integrity	Primary opportunities to address risks to integrity
Range 1	1. Highest level of juniper woodlands 2. High road densities 3. Low forest, range, and composite integrity 4. Moderate aquatic and hydrologic integrity 5. Fire regimes are more severe	1. Juniper encroachment into shrubland 2. Forage for ungulates (wild/domestic) reduced through woodland encroachment 3. Noxious weed expansion	1. Reduction of forest stocking could improve forage/cover relationships for livestock and big game 2. Curtailment of juniper expansion 3. Curtailment of noxious weed expansion 4. Management of riparian areas to enhance stream bank stability and riparian vegetation
Range 2	1. Forested rangelands in moderate to high integrity 2. High aquatic, hydrologic, and composite integrity 3. Minimally roaded	1. Fish and aquatic systems from dry vegetation types with fire severity/frequency changes 2. Dry forest types - especially late/old structures 3. Aquatic system sensitivity to disturbance	1. Restoration of vegeta tion and fuels treatments in dry forest types 2. Maintenance of aquatic and hydrologic integrity - emphasize connectivity 3. Restoration of mainte nance sagebrush ecotone 4. Restoration of forage production in winter range
Range 3	1. Low forest and range integrity 2. Low and moderate hydrologic, aquatic, and composite integrity 3. Highly roaded	1. Conflicts with big game management from conifer invasion reducing forage 2. Elevated fuel and fire from conifer invasion 3. Riparian conditions from disturbances 4. Increased susceptibility to insect, disease, and fire in forested areas	1. Management of to restore/ maintain riparian conditions 2. Prescription of fire to reduce risks from fire, insect, and disease in forested areas 3. Containment of noxious weeds 4. Maintenance of water quality for native and desired non-native fish
Range 4	1. Very low levels of FS/BLM lands 2. Lowest integrity in all components 3. Low levels of residual rangeland	1. Reduced fish habitat and populations from agricultural conversions	1. Reduction of threats to local populations of fish and their habitat
Range 5	1. Minimally roaded 2. Low croplands and other disturbances 3. High hydrologic and forest integrity 4. Moderate and low range and aquatic integrity 5. Moderate and high composite integrity	1. Continued declines in herb- land and shrubland habitats 2. Risks to local populations and habitats for fish	1. Maintenance restoration of riparian condition 2. Restoration of productive aquatic areas 3. Conservation of fish strongholds and unique aquatic areas
Range 6	1. Highly roaded 2. Highly altered from grazing and fire exclusion 3. High exotic species 4. Low composite integrity	1. Continued declines in herb- land and shrubland 2. Dry shrubland highly sensitive to overgrazing and exotic grass and forb invasion	1. Containment of exotic weed expansion 2. Maintenance restoration of riparian conditions 3. Management of grazing intensity, duration, and timing 4. Conservation of fish strongholds and unique aquatic areas

Social and Economic Resiliency

Much like the biophysical components of the ecosystem, social and economic resiliency are affected by the size of the area measured (such as community, county, or trade region).

Socioeconomic resiliency, estimated at the county level for this analysis, deals with the adaptability of human systems. High ratings imply that these systems are highly adaptable; changes in one aspect are quickly offset by self-correcting changes in other sectors or aspects. High levels of socioeconomic resiliency should reflect communities and economies that are adaptable to change, where "sense of place" is recognized in management actions, and where the mix of goods, functions, and services that society wants from ecosystems is maintained.

Much like the biophysical components of the ecosystem, social and economic resiliency are affected by the size of the area measured (such as community, county, or trade region) but reflect human notions of the landscape rather than hydrologic subbasins. In general, larger units display greater economic diversity (and by extension, economic and social resiliency) than smaller areas.

Economic Resiliency—This was measured by the diversity among employment sectors. The assumption is that people in high resiliency counties have ready access to a range of employment opportunities if specific firms or business sectors experience downturns. Little variation in economic diversity is found across the Basin at the scale of BEA regions. The relatively high levels of diversity (0.80 average on a scale of 1.0) at this scale reflect rapid growth in the Basin since the mid 1980s. Furthermore, the economy of the Basin has shown resistance to national recessions except when they greatly affect the agricultural sector. The highest resiliency ratings are for the Boise, Idaho Falls, Missoula, and Spokane BEA regions.

Estimating resiliency at the county level based on employment diversity provides a different picture, requiring some care to interpret. The average resiliency index for the 100 counties in the Basin is 0.70, much lower than the average calculated for the much larger BEA areas. This difference suggests that employment options, and thus employment diversity, is less at the county level than at the subregional (BEA) level.

Social Resiliency—This was measured at the community scale using four factors: (1) civic infrastructure (that is, leadership, preparedness for change); (2) economic diversity; (3) social/cultural diversity (population size, mix of skills); and (4) amenity infrastructure (that is, attractiveness of the community and surrounding area).

In general, communities that are smaller and have lower resiliency in the Basin follow the arid crescent that reaches south from the Columbia Plateau in eastern Washington, around the western and southern boundaries of the Blue Mountains in Oregon, and continues east along the Snake River plains in Idaho. This zone receives less than 12 inches of precipitation each year.

Communities that exhibit higher resiliency are located along the Cascade Range, the central mountains of Idaho, and in the vicinity of Missoula, Montana. These communities have more diverse economies than those that are located in the arid crescent. They also have the region's fastest rates of human population increase and contain recreation settings that receive the greatest amount of recreational use. These areas contain the highest

A community that may be currently rated as less resilient than others may still be able to demonstrate resiliency fairly quickly, even in the absence of strong economic structure or diversity, larger population size, or other typical indicators of resiliency.

Map 21—Socioeconomic resiliency ratings by county.

concentrations of Forest Service-administered lands, have more rainfall, and are generally montane environments.

When interpreting social resiliency, it should be kept in mind that humans are highly adaptable. Many communities have successfully addressed change through mobilization of community residents and energy. In other words, a community that may be currently rated as less resilient than others may still be able to demonstrate resiliency fairly quickly, even in the absence of strong economic structure or diversity, larger population size, or other typical indicators of resiliency.

Socioeconomic Resiliency—This composite rating, developed at the county level, combines three factors discussed as part of social and economic resiliency: population density (expressed as people/sq. mile); economic resiliency (defined by economic diversity); and lifestyle diversity. The combined score for a given county was developed by weighting each of these three factors equally.

A low rating applies to 54 Basin counties with low population density (less than 11 people/sq. mile), low or medium economic resiliency and low or medium lifestyle diversity (**map 21**). These counties account for 68 percent of the area but only 18 percent of the population. Some counties lack sufficient population to sustain existing services or to develop necessary social services. A related concern is whether these counties are able to maintain the existing infrastructure both in the physical and social senses especially in terms of community. One example is counties that are too sparse to sustain a medical clinic.

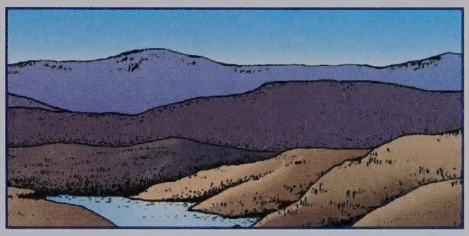
Another 20 Basin counties were rated as having an intermediate level of resiliency; these were associated with mostly medium economic resiliency ratings and generally either medium or high lifestyle diversity or population density ratings.

A high socioeconomic resiliency rating applies to the 26 Basin counties that are more densely populated (greater than 11 people/sq. mile) and these counties have the highest level of economic resiliency. Counties with high socioeconomic resiliency typically have high population densities, medium economic resiliency, and medium to high lifestyle diversity values.

The results for socioeconomic resiliency are somewhat deceptive. While 68 percent of the area within the Basin is rated as having low socioeconomic resiliency, 67 percent of the people of the Basin live in areas with high socioeconomic resiliency. One should not assume that those who live in areas of low resiliency experience low economic or social well-being, just as one should not assume that those living in areas of high resiliency experience high economic or social well-being.

Finally, it is incorrect to associate high or low resiliency at the county level with individual communities within counties, and would also be inappropriate to equate high or low resiliency with quality of life or the desirability of a county as a place to live. These relative ratings are intended only to show relative levels of vulnerability to change.

THE FUTURE OF THE BASIN: ANALYSIS OF MANAGEMENT OPTIONS



The preceding discussions have focused on present conditions and trends in the Basin and how they have been affected by past events and actions. It would be useful to discuss how these conditions could change in the future, but this depends to a large extent on how society chooses to manage lands, waters, and activities that affect ecosystem functioning. Because the ICBEMP is focused on management of FS and BLM lands in the Basin, future management of these lands and associated resources is especially relevant.

However, future management direction is yet to be determined. In this absence, the Science Team considered three broad management options and how Basin ecosystem conditions would likely be affected under each. This provides a way to show the extent to which alternative management strategies for FS and BLM lands would be likely to influence existing conditions and trends. This also provides a means to discuss risks and trade-offs associated with different strategies.

Management Options

The analysis of management options involves four major steps. First, alternative management strategies are defined. Second, future conditions for ecologic and economic systems within the Basin are estimated. Third, trends in ecological integrity under each alternative are modeled for the next 100 years. This starts with the current composite ecological integrity and examines indices that reflect change in composite integrity. Fourth, estimates of the socioeconomic resiliency associated with the alternatives are developed. Because of limited abilities to forecast overall economic activity, changes in socioeconomic resiliency are made for the next decade. The estimated shift in population density for the next 50 years is used to represent socioeconomic change in the Basin.

Option 1—The management specified under existing FS and BLM plans would continue. Implementation of this option would occur assuming continuation of recent budgets and no interim direction (such as interim riparian management directives). Existing FS and BLM plans include Regional Guides, Forest Plans (for each National Forest), and Resource Management Plans and Management Framework Plans (for BLM Resource Areas). Option 1 includes direction from current land-use plans of 35 National Forests and 17 BLM Districts.

Although substantial variation exists among agency plans, the general management approach is to emphasize or accommodate sustained timber and livestock forage production in an environmentally prudent manner while managing and protecting other resources and values. Timber and livestock management are integrated and coordinated with the maintenance or enhancement of wildlife and fish habitat, scenic quality, recreation opportunities, and other resource values to achieve overall multiple-use goals and objectives. On many areas, management of other

resources or values is emphasized such as recreation, wilderness, big game and fish habitat, or cultural resources. The current plans were developed with little or no attempt to coordinate management with other FS or BLM administrative units (that is, National Forest or BLM District).

Option 2—This management strategy would attempt to reduce risk to ecological integrity and species viability by aggressively restoring ecosystem health through actively managing resources; the results of management can resemble disturbance processes including insects, disease, and fire. The option focuses on short-term (5-10 years) vegetation management to improve the likelihood of moving toward or maintaining ecosystem processes that function properly in the long term (50-100 years). Vegetation management is designed to reduce risks to property, products, and economic and social opportunities that can result from large disturbance events. Direct involvement with state, county, and tribal governments is used in planning, decision-making, and implementation of programs.

Priority in this option is placed on forest, rangeland, and watershed health, assuming that healthy streams, wildlife populations, and economic and social benefits will follow. Actions taken to achieve desired conditions are designed to produce economic benefits whenever practical. A wide variety of management tools is available under this option.

Option 3—This option would attempt to reduce risk to ecological integrity and species viability by establishing a system of reserves on FS- and BLM-administered lands. Reserves would be located to include all representative vegetation types and be large enough to contain disturbance events typical to those vegetation types. The level of human use and management would be low within the reserves. Ecological disturbance events are expected and would occur naturally within the reserves. When disturbance events (such as fire and disease) occur, actions would be taken to reduce the likelihood of the event extending beyond the boundary of the reserve.

Most restoration activities would occur on lands managed by the FS and BLM outside reserves, although restoration actions could be taken within reserves where there is a high risk for events occurring in the short term that would preclude achieving desired outcomes in the long term (for example, maintaining habitats for endangered or threatened species or other scarce habitats, or controlling erosion by rehabilitating roads). Management outside the reserve boundaries includes an emphasis on conserving remaining old forest stands and roadless areas larger than 1,000 acres.

Reserves are assumed to be selected for representation of vegetation and rare animal species. Although some reserves may be designed around the needs of single species, the intent is to conserve biodiversity across the landscape, and to meet the needs of species groups or communities. No commercial timber harvest is assumed to be permitted inside reserves, but limited silvicultural activities are allowed to enhance species viability. Livestock grazing is assumed to be essentially eliminated from reserves unless it is needed to improve the long-term conditions for which the reserve was established. Dispersed, low-impact recreation use is assumed to be allowed as long as it does not affect populations of rare species or their habitat.

Management of reserves is focused on long-term maintenance of ecological processes and conditions with which plant and animal species have evolved. Areas adjacent reserves are managed as buffers to help maintain reserves by avoiding barriers or breaks in the vegetation that would isolate the reserves. Management is allowed in buffers, but road densities are usually low. Reserves are connected where possible by vegetative corridors to allow interchange of animals. Management occurs within corridors also, but habitat conditions are important considerations for management activities to allow for dispersal of animals.

Smoke from fires is a concern that could be reduced through carefully designed prescribed burning to reduce the likelihood of wildfires.

Resource-Specific Outcomes

Landscape Ecology—The broad-scale landscape analysis of management options revealed substantial differences in outcomes in terms of disturbance processes, vegetation structure and composition, smoke projections, insect and disease mortality, and other elements. Continuing current management results in higher levels of wildfire and smoke, and increases in exotic plant invasions compared to managing with a restoration emphasis (Option 2). From a landscape perspective, elements likely to raise concerns resulting from a reserve emphasis (Option 3) are the high potential for large wildfires at the rural/wildland interface, and high levels of summer and fall smoke. The expansion of exotics is rated high or moderate across the options; reducing exotic expansion to a low level would require more aggressive approaches to containment and eradication than is proposed by any of the three options.

The relation between disturbance events (that is, fire, insects, and disease) and plant succession is affected by management activities. Continuing current management results in disturbances that reverse succession to a high degree, whereas

Continuing current management results in higher levels of wildfire and smoke, and increases in exotic plant invasions compared to managing with a restoration emphasis.

emphasis on restoration results in a high level of disturbance that accelerates succession. The reserve emphasis results in disturbance levels that are low in reversing, accelerating, and maintaining succession regimes. Thus, if the goal is to increase the area in late-successional forest types, the restoration emphasis is more effective.

The restoration emphasis shifts timing and intensity of smoke production to a great extent by reducing the smoke associated with wildfire and increasing the smoke from prescribed fire across several seasons of the year. Option 2 also maintains and restores vegetation structure and composition to more nearly approximate pre-European settlement conditions, and reduces the likelihood that large wildfires might occur at the rural/wildland interface.

There is little difference in total area within each terrestrial community at the Basin level over the 100-year timeframe. Tracking change of a specific area through time reveals much more change than these net numbers suggest. In total, specific areas with increases are offset by other areas with decreases. All of the alternatives result in reductions in the mid-seral forested vegetation types, the vegetation most susceptible to insect, disease, and fire at the current time. Late-seral forest vegetation does increase under each of the options.

Terrestrial Ecology—The status of terrestrial plant and animal species and their habitats on FS- and BLM-administered lands were assessed for each of the management options. Assessments were based on expert opinion concerning the likely outcome for species and their habitats. The experts were asked to make judgments about habitat conditions for historical, current, and future timeframes. Habitat outcomes were classed into five viability outcome categories with 1 being the most broadly distributed and 5 being isolated local populations with strong potential for extirpation (**table 10**).

Habitat for nearly all 173 species analyzed is most favorable under historic conditions, and less favorable at present. A comparison of the options to current conditions reflects a conservative view of humans' ability to restore ecosystems that have been heavily modified. Even Option 2, which has the most beneficial results, is projected to result in only moderate improvements over existing conditions. Option 1 is projected to result in continued declines in species viability. Option 3 would have intermediate results, but would more closely resemble those of Option 2. Compared on the basis of the number of species falling in the most favorable outcome categories (Outcomes 1 and 2), none of the options approach historic conditions.

Differences among options also were examined by determining the number of species that fall into Outcome classes 1, 2, or 3. The break between Outcome 3 and 4 is significant because Outcome 4 indicates conditions under which populations are largely isolated and Outcome 5 is associated with a high likelihood of extirpation. Option 1 is projected to support the fewest species at the level of Outcome 1, 2, or 3, while Options 2 and 3 would support the most. The number of species falling under Outcomes 4 or 5 in eastern Oregon and Washington varies across options (59 under Option 1, 41 under Option 2, and 45 under Option 3), and in the upper Columbia Basin (45 under Option 1, 32 under Option 2, and 33 under Option 3). Distinctions among options are further clarified by examining the number of species with significant changes (+0.5 units) in outcome. Habitat for few species is projected to improve under Option 1, and a significant number of species are projected to experience habitat and viability decreases. Option 3 shows approximately equal numbers of increases and decreases, while Option 2 shows more species for which habitat increases than decreases.

Cautions that apply to these analyses are based on the broad geographic and time scale of the

Habitat for few species is projected to improve under Option 1, and a significant number of species are projected to experience habitat and viability decreases.

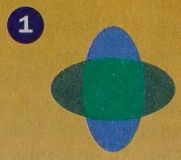
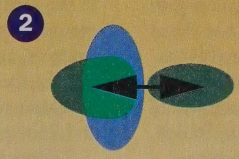
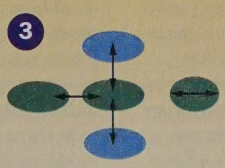
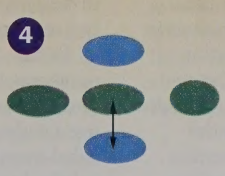
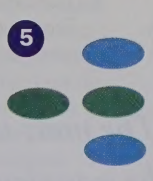
FS- and BLM-Administered Land		Cumulative Effects
Habitat is broadly distributed across the planning area with opportunity for continuous or nearly continuous occupation by the species, little or no limitation on population interactions.		Populations are broadly distributed across the analysis area with little or no limitation on population interactions.
Habitat is broadly distributed across the planning area but gaps exist within this distribution. Disjunct patches of habitat are typically large enough and close enough to other patches to permit dispersal among patches and to allow species to interact as a metapopulation.		Populations are broadly distributed across the analysis area but gaps exist within this distribution. Disjunct populations are typically large enough and close enough to other populations to permit dispersal among populations and to allow species to interact as a metapopulation.
Habitat exists primarily as patches, some of which are small or isolated to the degree that species interactions are limited. Local sub-populations in most of the species' range interact as a metapopulation, but some patches are so disjunct that sub-populations in those patches are essentially isolated from other populations.		The species is distributed primarily as disjunct populations, some of which are small or isolated to the degree that species interactions are limited. Local sub-populations in most of the species' range interact as a metapopulation but some populations are so disjunct that they are essentially isolated from other populations.
Habitat is typically distributed as isolated patches, causing strong limitations for population interaction among patches, and limited opportunity for dispersal among patches. Some local populations may be extirpated and rates of recolonization will likely be slow.		Populations are typically distributed as isolated sub-populations, with strong limitations in interactions of sub-populations and limited opportunity for dispersal among patches. Some local populations may be extirpated and rate of vacant habitat recolonization will likely be slow.
Habitat is very scarce throughout the area with little or no possibility of interactions among local populations, strong potential for extirpations, and little likelihood of recolonization.		Populations are highly isolated throughout the area with little or no possibility of interactions among local populations, strong potential for extirpations, and little likelihood of vacant habitat recolonization.

Table 10—Habitat outcome analysis.

analysis, the coarse resolution of the data and planning guidance, limitations on ability to infer population results from habitat analysis, and gaps in knowledge. As a result, these findings should be viewed as working hypotheses subject to testing under adaptive management.

Economics—In general the Basin is experiencing growth and has robust economies. This varies by county, community, and geographic area. The options are evaluated within the context of these current economic conditions. Regarding economic development, the effects of the options on jobs Basin-wide would be within one percent of those resulting from FS- and BLM-administered lands under continuation of current management. As a percent of all jobs in the Basin, the impact would be 0.1 percent. All three options increase Basin-wide employment in jobs resulting from recreation activity by 0.5 percent of total current Basin employment. In the east side portion of the project area, all three options would reduce timber employment by slightly less than the gain in recreation employment. Jobs associated with recreation activity do tend to pay less than timber jobs, but economic indicators in recreation counties are stronger than those in manufacturing counties.

Ten counties might experience negative effects from range management direction proposed under Option 3, but not from the other options. Twenty-one counties might experience positive economic effects from road management decisions in all options through their impact on recreation activity. Four of these are among the 10 range counties. All 16 timber counties might experience negative impacts to their timber sector under Options 2 and 3. Combining this information with measures of economic resiliency, two counties containing 0.5 percent of the Basin's population have economies that may be affected by the options. For most people in the Basin, expansion in other economic sectors means that the impacts of FS and BLM decisions will be negligible. If the agencies' goal is to minimize impact on economic resiliency, attention can be focused on these two counties.

Conclusions from the economic welfare analysis are quite different. The FS- and BLM-administered lands provide society with greater benefits from recreation and the existence of unroaded areas than from production of timber and cattle forage. Yet, at the margin, most of the impact under all options involves reduced timber production. From this standpoint, to justify selecting an option relative to Option 1, decision-makers would have to feel that the value of ecosystem outputs or conditions gained that are not included in the analysis (such as fish population improvements, improved water quality, reduced risk of wildfires and floods, and improved ecosystem health) are worth at least $33 million to $136 million annually in eastern Oregon and Washington, and $3 to $83 million annually in the upper Basin.

Effects on people who recreate in the Basin, who value the existence of unroaded areas, or who consume cattle raised on FS- or BLM-administered lands would be minor. Purchasers of lumber products will experience only minor changes in prices. The most significant negative effects will be experienced by people employed by the timber industry in the Basin. It is difficult to say how long these impacts would last, but given compensating increases in harvests from private land and the recent pace of economic growth, the transitions should be short-lived (based on experience in western Oregon and Washington, approximately five years).

Social—Projections of social consequences and outcomes associated with the options were developed primarily through a series of panels involving a wide array of publics, elected officials, and tribal members. These panels were particularly helpful in narrowing the scope of concerns and gaining insight into perceptions and values held by participants.

From a social perspective the five main areas of concern were: (1) predictability in commodity

The most significant negative effects will be experienced by people employed by the timber industry in the Basin.

Options 1 and 3 generally were predicted to have greater impacts and be less acceptable to more people compared to Option 2.

outputs and outcomes from the Federal lands; (2) public access to the decision-making processes; (3) primary or secondary effects that might occur on private lands; (4) effects on communities and the quality of life; and (5) effects on American Indian tribes. Options 1 and 3 generally were predicted to have greater impacts and be less acceptable to more people compared to Option 2—although in reality, individuals will find things they like and dislike about every option.

There is strong interest within the Basin concerning scenic quality, especially associated with FS- and BLM-administered lands. Even though 90 percent of the FS- and BLM-administered lands are rated as having high scenic integrity in the current situation, Options 2 and 3 provide slight increases in areas rated as high scenic integrity for the first decade.

There also is considerable public interest in road access issues. Each option considered a different level of emphasis on road closure and obliteration. At the 100-year timeframe for all options, FS- and BLM-administered lands would move to a higher percentage of moderate road densities by shifting away from higher road densities. In areas projected to have increases in road densities the increases were not projected to exceed moderate.

Aquatic ecology—The options were compared relative to their effectiveness in maintaining and protecting aquatic ecosystem function, structure, and processes, and to their expected effects on the effective distribution and abundance of habitat with reference to populations of 22 native fish species and subspecies. Specific emphasis was placed on protection, maintenance, and restoration of aquatic and riparian habitats.

The evaluation by species centered on each option's ability to conserve core and fringe areas, prevent declines in habitat and populations, and rehabilitate habitats and depressed populations. Core areas are concentrations of strong populations where the species is well distributed among adjacent watersheds. Fringe areas are where a relatively few occupied watersheds are isolated and fragmented from the larger portions of the species range, but have high genetic integrity or potentially unique genetic characteristics.

The species focus is primarily on seven key salmonids that are viewed as important indicators of aquatic integrity. Fifteen endemic, narrowly distributed species were also evaluated. Option 1 is predicted to be deficient in sustaining aquatic and riparian ecosystem function and structure through time. The result is a projection that further declines would not be halted for all of the key salmonids and 14 of the endemic species. Option 3 appears to provide a slightly more favorable outcomes associated with the key salmonids and the narrow endemics. The options result in varying levels of effectiveness in providing for ecological functions and processes. Each provides a different mix of protection and management processes related to aquatic/riparian systems The restoration emphasis and reserve emphasis are generally effective at maintaining and protecting riparian functions; Option 2 has the added benefit, as viewed from a manager's perspective, of increased flexibility.

Option 3 appears to provide a slightly more favorable outcome associated with the key salmonids and the narrow endemics.

Effects on Ecological Integrity and Socioeconomic Resiliency

The three options result in very different trends in ecological integrity. Continuing current management approaches (Option 1) results in declining trends in integrity on 95 percent of the FS- and BLM-administered land. If the goal is to manage for stable or improving trends in ecological integrity, the restoration emphasis (Option 2) meets this goal for all FS- or BLM-administered lands while the reserve emphasis (Option 3) meets the goal for 95 percent of the area. Management strategies that take a landscape approach and emphasize ecosystem processes and functions are more effective in improving ecological integrity in the future than are strategies that emphasize stand-level treatments and commodity production. In the restoration emphasis, substantial forested area is shown as stable, a future projection much improved over the declining trends projected for continuing the current management approaches. In the reserve emphasis, declines in intensity trends are mostly associated with impacts from natural events (for example, flood, fire, sediment, and erosion) or from very large events allowed within the reserves.

Changing the management approaches in the restoration emphasis to result in more area with improving trends (rather than the stable trends as projected) involves a complex set of interactions that must be considered. Decreasing road density would tend to shift toward improving trends, yet it complicates the ability to treat overstocked stands, increase the mosaic patterns on the landscape, and suppress wildfire in highly fragmented watersheds. Increasing prescribed burning, thinning, and harvest in the areas most susceptible to insect, disease, and fire create potential risk to aquatic resources. Addressing these issues requires careful prioritization of risks and identification of areas that will respond most effectively to treatment.

The rangeland situation also involves a complex set of interactions to consider in attempting to move to higher integrity. Exotic weed expansion, trends in riparian conditions, changes in fire regimes, and encroaching woody species remain primary concerns in these vegetation types even though rangeland areas have been improving over the last several decades. Rangeland conditions may not be as responsive as forested areas to the aquatic conservation strategies. Risks are also introduced when no restoration is undertaken. Roads with poor drainage networks, and increased insect and disease susceptibility, are examples where failing to take action may increase risk to ecological integrity.

Predicting trends for social and economic resiliency is difficult because of the inherent uncertainty in social systems. Some may draw the conclusion that we have impoverished ourselves and that ecosystem and human community sustainability is imperiled. Such a view at the Basin level leads to erroneous conclusions. First, the forest and range ecosystems do not, in themselves, provide the economic foundations of the Basin. Second, many of the ecosystems have been modified by human action to increase their production of native (for example, timber and grass) or exotic (for example, wheat or cattle) crops or animals.

Much of the Basin is expected to remain rural, where risks are associated with residents, and in primitive areas, where risks are associated with visitors. Local publics will be expected to continue to express preferences for stability in scenery and lobby to have projects put in someone else's backyard. Recreation use is expected to increase sharply leading to greater conflicts between recreation use and land management actions including road closures. The proportion of the Basin that is sparsely populated and where Federal agencies are a visible part of the communities is projected to change very little, and people will continue to

In general the greatest opportunities for restoration are in those areas with moderate or low ecological integrity.

Managing FS and BLM resources under an approach that continues current management (Option 1) generally results in the lowest ratings compared to other options.

place demands on Federal resources that are seen as part of their community infrastructures.

In general the greatest opportunities for restoration are in those areas with moderate or low ecological integrity; substantial opportunity exists in the dry and moist forest clusters and the rangeland clusters having moderate or low ecological integrity. There are also significant human populations in these same areas which could directly benefit from improved ecological conditions. Another opportunity to improve ecological integrity is in areas associated with moderate integrity that are positioned between large blocks of high integrity. They represent areas where terrestrial and aquatic systems can be connected; examples include the Blackfoot and Bitterroot areas of western Montana.

Timber and range outputs can be concentrated in those areas of moderate integrity with low fire risk (for example, the moist forest and range grouping). Commodity production can come from areas that have low or moderate integrity but are candidates for restoration. In these areas there are low down-side risks both from fire and hydrologic problems. In addition, almost all of the isolated resource-dependent communities are in these areas, where maintaining commodity flows could have a positive effect on community resiliency.

Many of the opportunities for ecosystem restoration are in riparian areas.

Summary of Outcomes

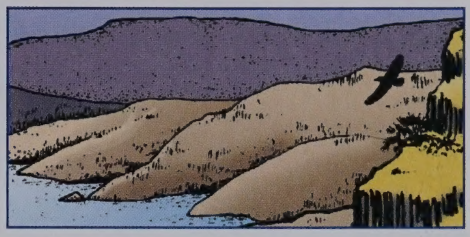
Managing FS and BLM resources under an approach that continues current management (Option 1) generally results in the lowest ratings compared to other options. Results would include declines in species habitat and populations, increases in fire severity, continued declines in fish habitat and population strongholds, and continued departures from historical disturbance processes. Trends would generally be decreasing composite integrity and increasing risks in terms of people and ecological integrity interactions. From a social and economic perspective this option would continue, and even accelerate, many of the conflicts in resource use present today.

Managing FS and BLM resources under a reserve area approach (Option 3) generally results in mixed outcomes relative to ecosystem management goals. This approach improves aquatic and terrestrial habitat conditions compared to continuing current management approaches, yet large severe fires are projected to have detrimental affects on landscape patterns and processes. Currently degraded systems within the reserve areas would recover very slowly, with some not recovering for hundreds of years. Trends in composite integrity and the risks to people and ecological integrity interactions will, for the most part, be improving (decreasing risk) or stable, albeit at a slightly lower level than for the restoration management emphasis. The social and economic effects associated with a large reserve system will be highly variable, mostly depending on the resiliency of the communities and counties in close proximity to the reserves.

Managing FS and BLM resources under a restoration emphasis approach (Option 2) within the Basin generally results in outcomes that are more consistent with long-term disturbance processes, have fewer species with declining habitat outcomes, and generally halt the decline of salmonid fish habitats as compared with the current approaches or with managing a network of reserves. It results in stable or improving trends in composite integrity, and also results in decreasing or stable trends in the risk to people and ecological integrity for most of the area. While having some negative effects on social and economic elements, it appears to be the most responsive to American Indian tribal concerns and public acceptability objectives, and to contribute to overall economic and social resiliency.

When compared with traditional approaches, active management appears to have the greatest chance of producing the mix of goods and services that people want from ecosystems, as well as maintaining or enhancing the long-term ecological integrity of the Basin.

CONCLUSION: FROM SCIENCE TO MANAGEMENT



The main purpose of the Science Team's effort was to provide a description and explanation of current physical, biological, economic, and social conditions and trends in the Basin. The next step is for land managers to decide how to use these findings to manage Forest Service and Bureau of Land Management-administered lands in the Basin. This is anticipated to be done according to procedures specified by the National Environmental Policy Act—in this case, through development of two environmental impact statements (EISs), one covering the east-side (eastern Washington and Oregon) and the other covering the upper Columbia basin (Idaho, northwestern Montana, and portions of Nevada, Utah, and Wyoming).

The EISs are expected to describe and evaluate a set of possible management alternatives, including descriptions of desired future conditions, objectives and standards for managing FS and BLM lands, and the types of activities that would be undertaken to address ecosystem conditions. Release of Draft EISs is followed by a public comment period, after which they are revised and published as Final EISs. Agency decision-makers then publish a Record of Decision describing which alternative has been selected for management of FS- and BLM-administered lands, and how it will be implemented. For this project, the Record of Decision would contain additional detail about how existing FS and BLM management plans would be changed to reflect the new Basin-wide emphasis. Any new direction is expected to supplement and modify existing plans, not replace them. This would be done to make sure that each management unit is being administered with the larger ecosystem picture in mind.

In conclusion, the role of this science assessment in the natural resource policy arena of the interior Columbia Basin is to characterize conditions, describe risks and uncertainties, and project trends and outcomes likely from management options. A massive undertaking such as this is not likely to be completely satisfying to anyone. It owes its existence, its success, or its failure to no single individual. It represents biophysical and socioeconomic elements at a scale never before attempted, and is therefore viewed by its authors as only a beginning. The task of fully understanding ecosystem processes and functions is one that will never be completed.

The future holds uncertain outcomes. Politics, the courts, public sentiment, policy, management, and science all intermix in a complex web that defies certainty in future projections. Science has provided information about strengths and weaknesses in the Basin's ecological and socioeconomic systems that should enlighten and motivate the debate about future options. The science process has improved understanding of potential outcomes, consequences, and interactions.

The role of science now shifts to a new arena as the complex interactions in the public policy process continue. In the end, society moves toward changed relationships, new direction, and new processes that will define stewardship of natural resources into the next century. There is no stepping back nor denying that change is imminent; as this round of change concludes, another begins. We hope that the information contained in the science documents and summarized here provides a starting point for these discussions.

U.S. Department of Agriculture, Forest Service. 1996. Status of the interior Columbia basin: summary of scientific findings. Gen. Tech. Rep. PNW-GTR-385. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station; U.S. Department of the Interior, Bureau of Land Management. 144 p.

The *Status of the Interior Columbia Basin* is a summary of the scientific findings from the Interior Columbia Basin Ecosystem Management Project. The Interior Columbia Basin includes some 145 million acres within the northwestern United States. Over 75 million acres of this area are managed by the USDA Forest Service or the USDI Bureau of Land Management. A framework for ecosystem management is described that assumes the broad purpose is to maintain the integrity of ecosystems over time and space. An integrated scientific assessment links landscape, aquatic, terrestrial, social, and economic characterizations to describe the biophysical and social systems. Ecosystem conditions within the Basin have changed substantially within the last 100 years. The status of ecosystems is described in terms of current conditions and trends under three broadly defined management options. The scientific information brought forward will be used in decision-making, and may potentially amend Forest Service and Bureau of Land Management plans within the Basin. The information highlighted here represents an integrated view of biophysical and socioeconomic elements at a scale never before attempted. The risks and opportunities are characterized in the broad context of the Basin for managers and the public to use as a foundation for discussion about future management.

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